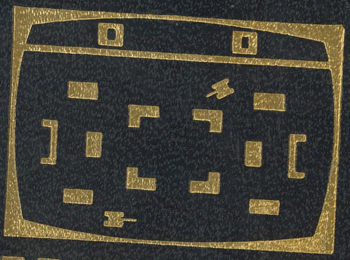

# How to Repair Video Games

By Robert Goodman

1028 How to Repair Video Games Good

# How to Repair Video Games

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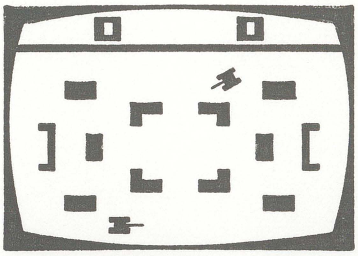

# How to Repair Video Games

By Robert Goodman

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Cover photo courtesy Bally Manufacturing Corporation.

# FOREWORD

Just about now the dust is beginning to settle from all of the activity stirred up over consumer electronic video games. Things hadn't really returned to normal from the CB craze when everything went wild again. The new-born microprocessor chip opened many doors in the field of home entertainment electronics.

A new element has crept into the electronics industry from other consumer fields that has put the independent electronics technician in a difficult position—product security. This element has always been a key factor in the toy industry, in order to get the jump on competitors. Since the tight-lipped security of the toy industry has found its way into consumer electronics, the ET has been faced with the problem of obtaining service literature.

But now things have calmed down at bit, manufacturers realize that service is an important factor in product sales. It is through this realization that this service manual is being published. You will find service information for products of leading manufacturers of electronic games within this manual. This will fulfill your need for up-to-the-minute of service literature for electronic video games.

Each chapter of the service manual is devoted to one manufacturer's equipment. You'll note that some manufacturers covered here are equipment manufacturers, while others produce game chips only. The three game chip manufacturers dealt with here are General Instrument, Texas Instruments, and National Semiconductor. Products from these companies are to be found in many brands of video games and microprocessor-controlled devices.

Equipment manufacturers covered here include Magnavox, Atari, Radio Shack, RCA, and Midway. Products of the first four companies are video games, while Midway deals with electronic pinball machines. At this time, Midway has its programmable video game project under way, but no service information is available at this time.

TAB BOOKS and I would like to thank all of the contributing manufacturers for the technical information they supplied to make this service manual possible. Special gratitude goes to members of the service and promotion departments in these companies for cooperation and assistance during the preparatory stages of this manual.

Mike Fair
TAB Editorial Staff

# CONTENTS

# CHAPTER 1

# TROUBLESHOOTING DIGITAL CIRCUITS

Typically, one might be tempted to throw his hands up in the air and quit the electronic service business when confronted with the digital signals that flow through the arteries of consumer electronic games. What was once a world of analog signals, such as sine waves and sawtooths, has rapidly become one of bits, bytes, and pixels. The time has come, as it was when the transistor was introduced, for the electronic technician to hit the books again. The transistor has been reduced to the size of a pinhead in a maze of silicon called an IC.

It all sounds so complicated, doesn't it? But in reality it is much simpler than yesterday's circuits. Those of us born out of military electronics are familiar with the term black box changers. This is the technician that doesn't really repair anything—he just goes around changing defective pieces of equipment with ones that work properly. The equipment used was generally enclosed in black boxes, thus black box changer. In effect, the IC has become a black box, housing thousands of tiny circuits that once required the space of several black boxes. Instead of locating a defective discrete transistor, now the technician's job has him replacing thousands of solid-state components within a single package.

Well, how does a technician deal with these circuits? The answer is simple—the same way that you dealt with the analog circuits. You may not need any additional test equipment, depending on your own personal likes and dislikes. For myself, a good dual-trace scope and a high-impedance voltmeter take care of most of my needs. Logic probes are very nice but not an absolute necessity. So you see, we're back to the old standbys, the scope and meter. These are the technician's best friends.

Nevertheless, logic probes do speed the technician's work. He must, however, know how to properly use the device and interpret its indications.

## SIMPLE LOGIC PROBES

To check the test point of a timer or counter reset, where the logic is supposed to generate a brief pulse, a simple logic probe as shown in Fig. 1-1 is very useful. This one uses a SN7400 chip and a 2N3904 transistor. It is simple to build and parts placement is not critical.

It's also simple to build the logic probe described in the circuit diagram of Fig. 1-2. It is good for basic logic troubleshooting techniques.

The LED should be mounted as close to the probe test tip as you can get it. All of the components can be mounted in a slim plastic tube or small box.

When the probe is touching a *one* signal, the LED is on, and when it sees a *zero* signal, the LED is off. When it samples a pulsing signal, the LED is on at reduced brightness.

When using a logic probe, always place the test tip probe on the IC leads. Do not place the test tip on

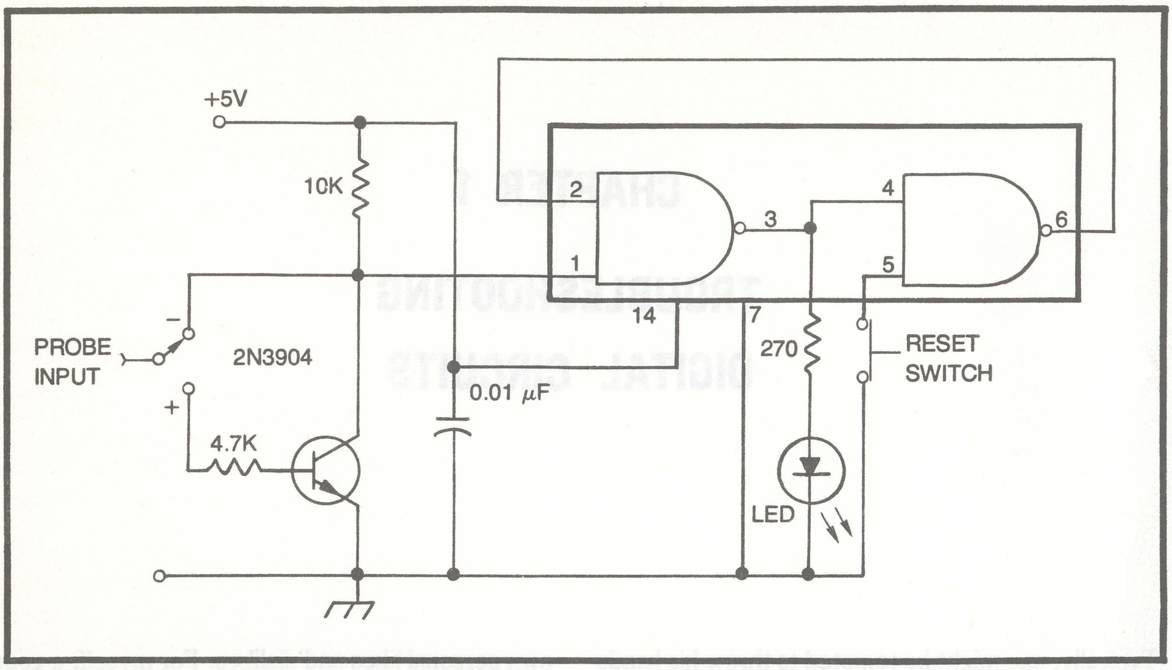



Fig. 1-1. A simple logic probe that you can construct. The probe uses a 2N3904 transistor, an SN7400 IC chip, and an LED.

socket as there may be a poor socket connection, which could give a false indication if the signal is an input to the IC.

## CONTINENTAL SPECIALTIES PRODUCTS

The logic probe shown in Fig. 1-3, the LP-2, detects, memorizes, and displays logic levels, pulses, and voltage transients in mixed and single logic family systems. It detects out-of-tolerance logic signals, open-circuit modes, as well as transient events down to 50 nanoseconds (ns) while providing the user with an instant high-intensity LED readout.

The probe tip of the LP-2 is connected to a dual-threshold window comparator and a bipolar edge detector. The window comparator bias network sets the logic *one* and logic *zero* threshold levels. Levels are fixed in the DTL/TTL mode at 2.25V and in the CMOS/HTL (High Threshold Logic) mode at 0.8V.

The bipolar edge detector responds to both positive and negative transitions and drives a pulse-stretcher circuit. The pulse-stretcher circuit converts level transitions as well as narrow pulses to 0.3333-second pulses that drive one of three readout LEDs. In the memory mode, the output of the edge detector is fed to a latching flip-flop.

Another logic probe manufactured by Continental Specialties is the LP-3 shown in Fig. 1-4. It adds a unique and highly sensitive pulse-detecting system capable of catching pulses faster than 10 ns.

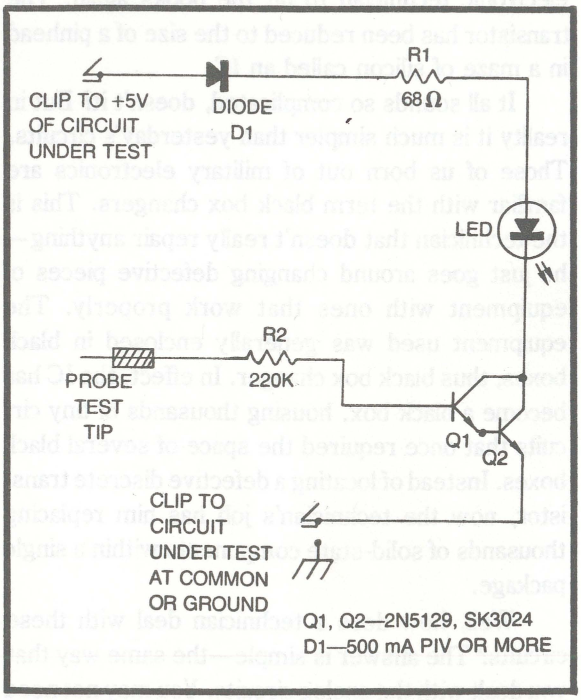



Fig. 1-2. Another simple logic probe easy to construct.

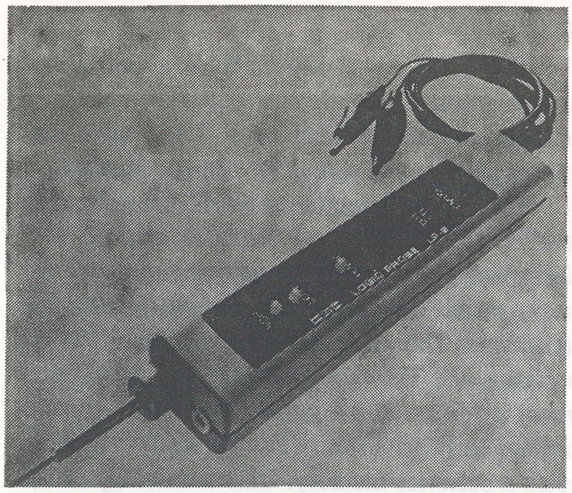



Fig. 1-3. The LP-2 logic probe by Continental Specialties.

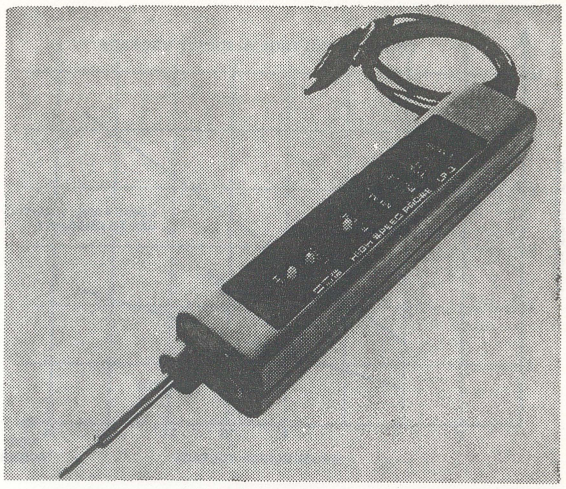



Fig. 1-4. The LP-3 high-speed logic probes by Continental Specialties.

This insures capture of glitches and spikes for all logic families: TTL, DTL, RTL, and CMOS.

To use the LP-3, connect the logic probe clip leads to the circuit's power supply that you are testing. Then set the logic family switch to DTL/TTL or CMOS/HTL. Set the memory/pulse switch to the pulse position. Touch the probe's tip to the circuit node to be analyzed. The three display LEDs on the probe body will instantly provide a reading of the signal activity at the node. The memory mode of the LP-3 is used to detect, store, and display low repetition rates or single-shot pulses, as well as transient events, even when an observer is not around when they occur.

A chart for interpreting the action of the logic probe's LEDs is found in Fig. 1-5. The first column of the chart shows the LEDs' states. A dark circle indicates an on condition, while an open circle indicates an off condition. The asterisk indicates a flashing condition.

Actual potentials that indicate a logic *one* or logic *zero* do vary, depending on the supply voltage to the probe. That is, what is a logic *one* of a system using a set value of Vcc for operation can be logic *zero* for another system using a different value of Vcc. The relationship of probe tip voltage versus supply voltage is shown in Fig. 1-6. The values shown are with the logic family switch in the CMOS/HTL position.

These probes are protected against overvoltage and reverse voltage on the power leads. The black lead should be connected to common (negative) and the red lead connected to Vcc (positive). In order to minimize the possibility of power supply spikes or other suprious signals affecting the operation of the probe, you should connect the power leads as close as possible to the node to be tested.

The LP-3 has some special features not found in the less expensive LP-2 version. We'll examine these extra features now.

| LED STATES HIGH | LO | PULSE | INPUT SIGNAL | |
|---|---|---|---|---|
| ○ | ● | ○ | | LOGIC "0" NO PULSE ACTIVITY |
| ● | ○ | ○ | | LOGIC "1" NO PULSE ACTIVITY |
| ○ | ○ | ○ | | ALL LEDS OFF 1. TEST POINT IS AN OPEN CIRCUIT. 2. OUT OF TOLERANCE SIGNAL. 3. PROBE NOT CONNECTED TO POWER. 4. NODE OR CIRCUIT NOT POWERED. |
| ● | ● | * | | THE SHARED BRIGHTNESS OF THE HI AND LO LEDS INDICATE A 50% DUTY CYCLE AT THE TEST POINT. (<100KHz) |
| ○ | ○ | * | | HIGH FREQUENCY SQUARE WAVE (>100KHz) AT TEST NODE. AS THE HIGH FREQUENCY SIGNALS DUTY CYCLE SHIFTS FROM A SQUARE WAVE TO EITHER A HIGH OR LOW DUTY CYCLE PULSE TRAIN EITHER THE LO OR HI LED WILL BECOME ACTIVATED. |
| ○ | ● | * | | LOGIC "0" PULSE ACTIVITY PRESENT POSITIVE GOING PULSES SINCE HI LED NOT "ON" PULSE TRAIN DUTY CYCLE IS LOW RE<15%. IF THE DUTY CYCLE WERE INCREASED ABOVE 15% HI LED WOULD START TO TURN ON. |
| ● | ○ | * | | LOGIC "1" PULSE ACTIVITY PRESENT NEGATIVE GOING PULSES, SINCE LO LED NOT "ON" PULSE TRAIN DUTY CYCLE IS HIGH RE>85% IF THE DUTY CYCLE WERE REDUCED TO <85% "LO" LED WOULD START TO TURN ON. |

● LED ON
○ LED OFF
* BLINKING LED

Fig. 1-5. Interpreting the LEDs on the Continental probes.

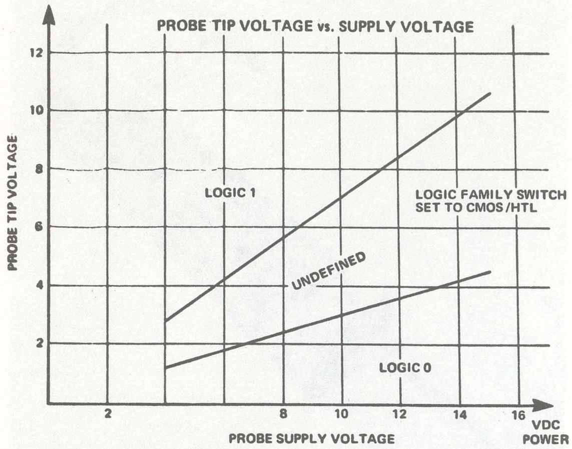



Fig. 1-6. Probe tip versus supply voltage chart.

## Memory/Pulse Switch

When the memory/pulse switch is in the pulse position, the LP-3 operates just as the LP-2. That is, each time the input signal changes state, the pulse LED is activated for 0.3333 seconds. When observing low-frequency or low-duty-cycle signals, the pulse LED provides a quick indication of the pulse activity at the mode under test. By observing the high and low LEDs, the phase of the pulse train can be determined. If the high LED is on, the signal is normally high, and vice versa. High-frequency signals cause the pulse LED to flash at a 3 Hz rate.

When the memory/pulse switch is placed in the memory position a new operation takes place. The LP-3 probe contains a pulse memory flip-flop that catches and holds (memorizes) level transitions or pulses as narrow as 50 ns. The memory is activated by either positive or negative level transitions.

To set the LP-3 probe for catching and memorizing an event, it is necessary to touch the probe tip to the mode under test with the pulse/memory switch in the memory position. This will activate the pulse LED. It will be latched *on*. To reset and rearm the memory the memory/pulse switch must be placed in the pulse position again momentarily, then placed back in the memory position.

When arming the memory, the probe tip must be in contact with the test point in question. If the memory is armed with the tip floating, the memory will be activated when the tip makes contact, thus yielding a false readout.

## Fast Pulse Catcher

The LP-3 probe also contains a unique and highly sensitive pulse-detecting system capable of catching pulses faster than 10 ns. This insures capture of glitches and spikes for all logic families.

The pulse detector network consists of a level-sensitive broadband amplifier coupled to a high-speed pulse-stretching multivibrator. This circuit is capable of firing on both positive and negative transitions. The pulse stretcher enables a 100 ms oscillator and LED driver circuit that produces a visual indication of the pulse catch. The oscillator can also be switched into a bistable mode in order to catch a pulse for memory. This technology allows the technician to catch and display hidden spikes and glitches that many scope and logic probes do not see.

Basic RF troubleshooting techniques are required as you try to locate these fast spikes and pulses. The LP-3's ground lead must be used. Ground lines must be as short as possible and as close to the test point as practical. In the case of an IC chip, the ground lead should be clipped directly to the IC's ground pin. The ground lead can supply the signal return and negative power line path for the probe and will help prevent ground loops.

## DP-1 Pulse Generator

Another device manufactured by this company is the DP-1. It is a completely automatic pulse generator that can be used for troubleshooting the microprocessor-type video games. You can pulse any family of digital circuits with this probe.

By obtaining its power from the circuit under test, the DP-1 self-adjusts the amplitude of its output pulse to the input requirements of the circuit to be tested. When the pulser tip is connected to the circuit mode to be tested, the probe's automatic polarity-sensing system selects the sink or source required to activate the test point.

By depressing the pushbutton on the DP-1, a clean bounce-free pulse is produced. When the pushbutton is held down for more than 1 second the unit produces a pulse train at a 100 pulses-per-second (100 pps) rate.

The pulser has a fail-safe feature that permits an overvoltage condition up to 25V. Other built-in protection will withstand a reverse voltage up to

50V. This same feature allows the unit to pulse continuously into a short circuit.

The DP-1 allows you, the service technician, all the versatility of a lab-quality pulse generator without the need to set pulse levels or switch to complement the output pulses.

## Automatic Polarity-Sensing Feature

The pulser contains a circuit that automatically selects the sink or source pulse needed by the circuit under test. By comparing the test point voltage (between pulses) to the center of the dead zone voltage of the IC being tested, the DP-1 senses whether a *zero* level is present and outputs a *one* pulse, or if a *one* level is present it outputs a *zero* pulse.

The automatic polarity-sensing level is checked after each pulse to allow for changes after a trigger pulse. This permits the DP-1 to trigger as an RS flip-flop supplying alternate sink and source pulses to a cross-coupled junction to keep the flip-flop toggling (Fig. 1-7).

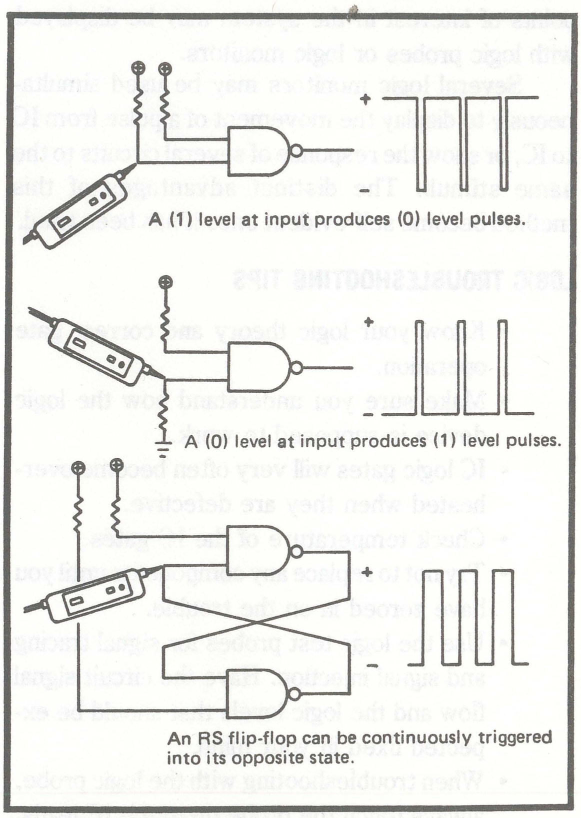



Fig. 1-7. Automatic polarity-sensing feature of the DP-1 pulser probe by Continental Specialties.

## Tri-State Output

The DP-1 is a tri-state output device with a minimum of 300K loading when not being pulsed. This allows all logic ICs, including CMOS, to be unaffected by probe loading between pulses.

## Single-Shot Mode

By depressing and releasing the pushbutton, a single debounced pulse is produced at the output. The pushbutton may be depressed as rapidly as needed to produce a controlled stream of single pulses. The pushbutton must be released within 1 second in order to remain in the single-shot mode. The LED flashes once for each single-shot pulse that is produced.

## Continuous Mode

When the pushbutton is depressed a single pulse is produced instantly. If, however, the button is held down for more than 1 second, the output switches from the single-shot mode to the continuous mode, producing a pulse train at a 100 pps rate. The LED stays lit in this mode of operation.

## TTL Mode

When the slide switch is in the TTL position the output pulse width is 1.5 $\mu$s. The pulse rise time is less than 100 ns, with a maximum of 500 ns storage and fall time for 1 TTL load. Storage and fall time decreases as TTL loading increases. The output can sink or source 100 mA or 60 TTL loads in this mode.

## CMOS Mode

With the slide switch in the CMOS position, the output pulse is 10 $\mu$s. This allows ample time for the slowest CMOS device to be activated. The pulse rise time is less than 100 ms with an 8 $\mu$s storage and fall time for 100K load resistance. The output pulse in this mode can sink or source 50 mA to a logic *one* or a logic *zero* level for any Vcc from +4V to +18V.

## Using the DP-1

The power cable of the DP-1 not only feeds power to the unit but also acts as the return path for the output pulse. In order to decrease common-moding and ground loops, it is necessary to clip the power cable lead as close to the pulsing point as

possible. When power is first applied to the pulser, the LED will light and stay lit for about 1 second. After the LED has gone off, the pulser is ready to use.

In most cases, it is not necessary to use the ground clip because the unit produces a crisp pulse under normal conditions. However, the ground lead does help the pulser sink larger currents and can reduce pulse storage time. If you elect to use the ground lead, do not hook up the black power lead because both leads cause common moding and ground loops, which can produce false triggering in the circuit under test.

The DP-1 is extremely effective in troubleshooting logic circuits. In many cases it is much more useful than an oscilloscope.

### Troubleshooting Gates

Although logic monitors work very well on counters, latches and flip-flops, they are basically static devices and cannot display the pulser's narrow output pulse.

When troubleshooting gating and decoding systems, a logic probe is needed for its pulse-stretching abilities. Here the DP-1's narrowest pulse can be caught and held for a third of a second. The HI/LO LEDs indicate that the mode under test is high pulsing low or low pulsing high.

In Fig. 1-8A, a two-gate circuit is being tested. G1's output is held high, causing G2's output to be low. By applying the pulser to the output of G1, the pulser overrides the high state of G1 and puts a train of *zero* pulses into the gate of G2. The logic probe connected to the output of G2 has its low LED on, but now the pulse LED starts flashing. This shows the gate is passing the input pulses in proper polarity.

In Fig. 1-8B, the probe is moved to the output of G1 and the pulser is applied to the low-gate input. The pulser now produces a series of *one* pulses when the pushbutton is held down. However, the probe's pulse LED does not respond, indicating a defective gate.

### Overriding a Logic State

With the pulser's high fan-out, it has the ability of overriding the output level set by a gate by applying the needed input pulse to the circuitry under test. This sets the stage for system troubleshooting

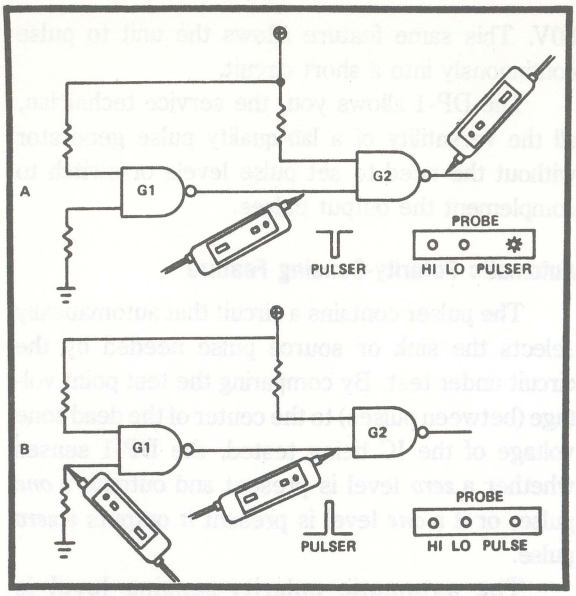


Fig. 1-8. Troubleshooting gates using the pulser along with a logic probe.

by using the jogging method. A digital system can be deactivated by disconnecting the system clock and replacing it with the pulser. The complete system may now be jogged through its cycle, while different points of interest in the system may be displayed with logic probes or logic monitors.

Several logic monitors may be used simultaneously to display the movement of a pulse from IC to IC, or show the response of several circuits to the same stimuli. The distinct advantages of this method become self-evident once it has been tried.

## LOGIC TROUBLESHOOTING TIPS

- Know your logic theory and correct gate operation.
- Make sure you understand how the logic device is supposed to work.
- IC logic gates will very often become overheated when they are defective.
- Check temperature of the IC gates.
- Try not to replace any components until you have zeroed in on the trouble.
- Use the logic test probes for signal tracing and signal injection. Have the circuit signal flow and the logic levels that should be expected fixed in your mind.
- When troubleshooting with the logic probe, always touch the probe tip to the IC leads. Avoid the probe tip test at the IC socket.

# CHAPTER 2

# RADIO SHACK TV SCOREBOARD GAMES

This chapter covers six TV games manufactured by Radio Shack: Models 60-3051, 60-3052, 60-3054, 60-3055, 60-3056, and 60-3057. Most of the diagrams in this chapter have been supplied by Radio Shack. Replacement parts for all six of these machines should be ordered from the following address: Radio Shack, Division of Tandy Corporation, 2617 West 7th St., Fort Worth, Texas 76107.

## TV SCOREBOARD MODEL 60-3051

This TV scoreboard game is divided into six major subsections. They are: game chip, power supply, video mixer, oscillator, modulator, and audio amplifier. Note the game specifications in Fig. 2-1.

Shown in Fig. 2-2 is a block diagram of the TV game electronics. The GI game chip (AY-3-8500-1) develops all video signals and processes the ball and paddle options, as well as receiving game selections from the selector switch. This IC performs all of the game functions. All other sections and components support this main IC. The crystal oscillator section supplies the master reference frequency of 2 MHz to the game chip. The video mixer section accepts five video outputs from the game chip and makes one composite waveform that is then fed to the modulator. The modulator, as its name implies, amplitude modulates the video information onto the carrier frequency. This carrier is of the proper frequency so that channel 3 or 4 may be used to receive the game. The audio amplifier section amplifies the audio generated by the game IC to drive the speaker.

### POWER SUPPLY

DC power is supplied by either an external AC adapter (9V DC) or six C-cell batteries arranged in series. If the AC adapter is plugged into jack J1, battery B1 is disconnected (Fig. 2-3). The batteries supply power anytime the AC adapter is not plugged into J1. There is no charging circuit for the batteries, and only one power source is connected to power switch S6 at any time.

When switch S6 is on, power is applied to the system. Resistor R1 limits current for zener diode CR1. Diode CR2 protects the unit from power supply load reversal. If we assume a 0.7V drop across diode CR2, then the voltage at the junction of CR1, R1, and C2 will be 7.1V nominal. This voltage is filtered by C2, a 220 $\mu$F electrolytic capacitor.

Transistor Q1 and the components around it form a series-pass regulator circuit. The action of electrolytic capacitor C2 and the gain of transistor Q1 is such that, electrically, there is a 22,000 $\mu$F capacitor between the emitter of Q1 and ground.

Inductors L1, L2, and L3, together with capacitors C1, C3, C4, and C7 prevent oscillator

| DC VOLTAGE | NOMINAL | MIN | MAX | UNITS | MEASURED AT |
|---|---|---|---|---|---|
| Battery | 8.3 | 7.0 | 9.0 | Volts | TP3 |
| AC Adapter* | 8.3 | 7.0 | 12.0 | Volts | TP3 |
| Vcc | 6.5 | 6.0 | 7.5 | Volts | TP5 |
| Vc | 6.4 | 6.0 | 6.7 | Volts | TP7 |
| **SIGNAL VOLTAGE** | | | | | |
| Horizontal and Vertical Sync | 6.7 | — | 6.7 | Volts P-P | TP13 |
| Buffered Video | 5.5 | 0 | 5.8 | Volts P-P | TP14 |
| Composite Video | 4.0 | — | 4.0 | Volts P-P | TP15 |
| Modulator Video | 2.0 | 0 | 2.0 | Volts P-P | TP16 |
| **FREQUENCY** | | | | | |
| Oscillator | | 2.01055 | 2.01377 | MHz | |

*The AC Adapter supplied with the TV game is a special type -**DO NOT ATTEMPT TO USE ANY OTHER ADAPTER WITH THIS GAME.** It provides 9 volts DC at 225 mA.

Fig. 2-1. Game specifications for the TV Scoreboard Model 60-3051.

harmonics from passing out of the TV game into the AC line whenever the AC adapter is in use (as per FCC). Note in Fig. 2-3 that L3 and C7 form a separate power supply, Vc, for game IC and oscillator IC. Also, notice inductor L2 in the ground circuit of the power input jack J1. Inductor L2 is only used when an AC adapter is plugged into J1. L2 has no effect under battery power. The audio stage uses

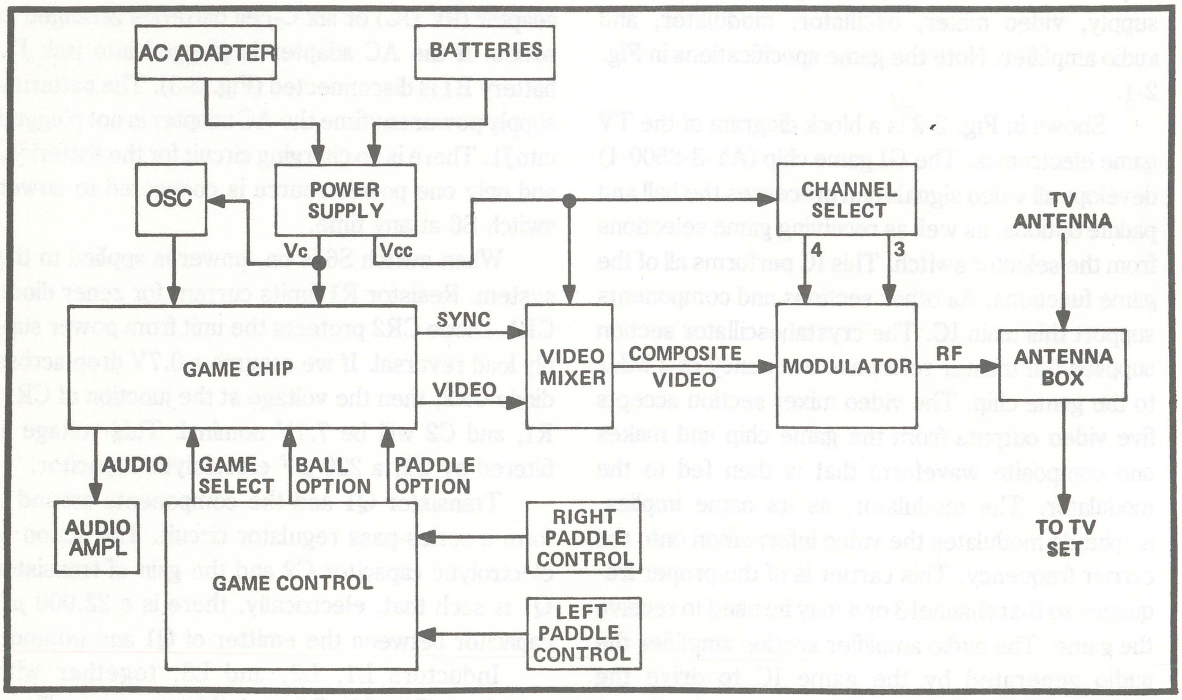



Fig. 2-2. Block diagram of the 60-3051 video game.

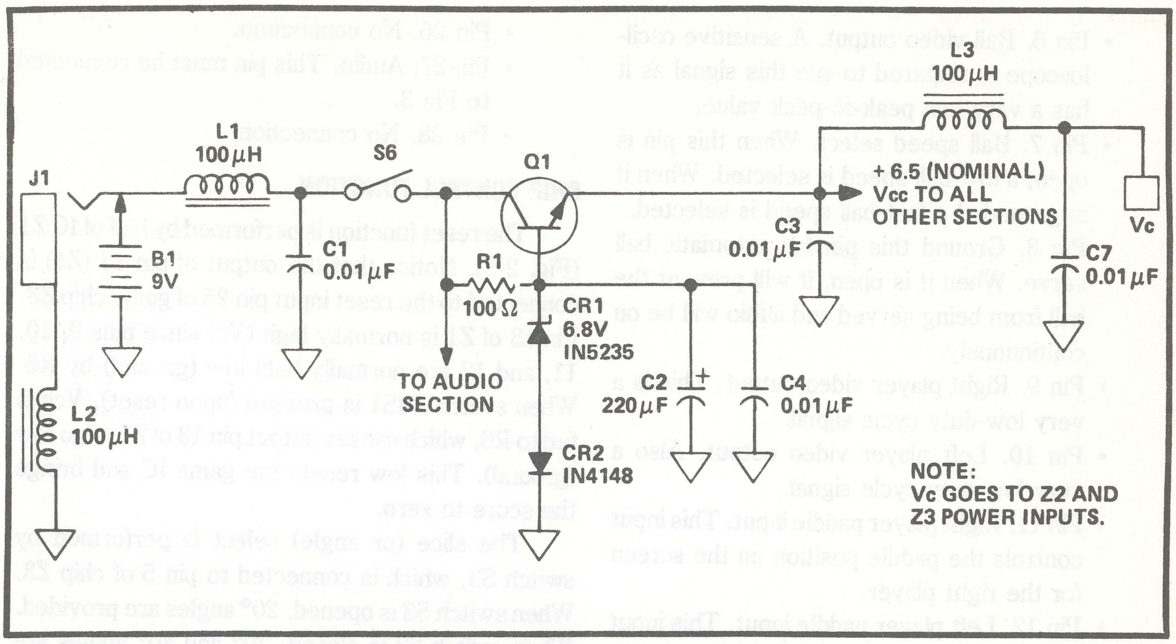



Fig. 2-3. Schematic of the power supply circuit for the 60-3051.

unregulated power since its requirements are not critical.

## CRYSTAL OSCILLATOR

The crystal oscillator circuit (Fig. 2-4) is a conventional CMOS crystal-controlled oscillator. Half of dual four-input NOR gate Z1 is used to provide 180° phase shift and to supply gain for crystal Y1. The crystal is the only frequency-determining component.

Three of the four inputs to gate Z1 are not used and are tied to ground. The other input is tied to resistor R5, crystal Y1, and capacitor C5. Resistor R5 is used to bias gate Z1 into a linear region, while R4 is a match to the series resistance of the crystal. Capacitors C5 and C6 provide phase shift and match the crystal and NOR gate capacitances. The 2 MHz signal is taken from the junction of R4 and R5. Note that the crystal container is grounded to minimize RF radiation.

## MOS GAME CHIP

IC Z3 is the MOS game chip. This IC supplies all sync, video, and logic necessary to present four games on most any standard B&W or color TV receiver. Since the entire TV game is logically implanted in this IC, a definition of inputs and outputs will be described by pin number.

## IC Z3 Pin Functions

- Pin 1. No connection.
- Pin 2. Ground or most negative supply input.
- Pin 3. Audio output.
- Pin 4. Vcc.
- Pin 5. Slice angle select. When this pin is open, the ball will always deflect at a 20° angle. A grounded pin allows the ball to deflect at either 20° or 40° angles.

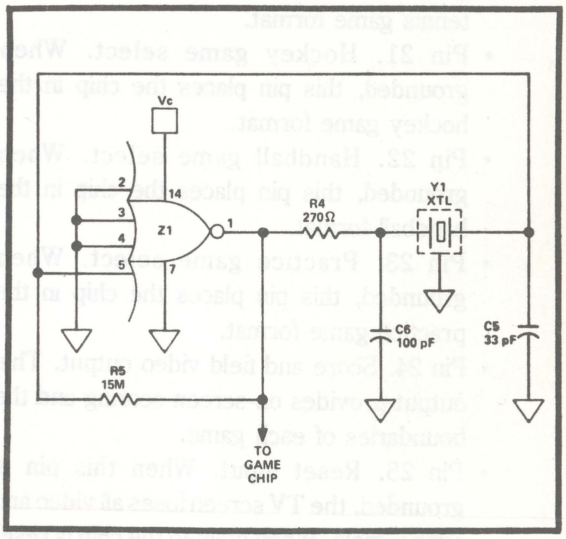



Fig. 2-4. Simplified schematic of the crystal oscillator in the 60-3051.

- Pin 6. Ball video output. A sensitive oscilloscope is required to see this signal as it has a very low peak-to-peak value.
- Pin 7. Ball speed select. When this pin is open, a low-ball speed is selected. When it is grounded a fast-ball speed is selected.
- Pin 8. Ground this pin for automatic ball serve. When it is open, it will prevent the ball from being served and audio will be on continuously.
- Pin 9. Right player video output. This is a very low-duty cycle signal.
- Pin 10. Left player video output. Also a very low duty cycle signal.
- Pin 11. Right player paddle input. This input controls the paddle position on the screen for the right player.
- Pin 12. Left player paddle input. This input controls the paddle position on the screen for the left player.
- Pin 13. Paddle size select. When this pin is open, a large paddle is selected. When the pin is grounded, a small paddle is selected.
- Pin 14. No connection.
- Pin 15. No connection.
- Pin 16. Vertical and horizontal sync output.
- Pin 17. Oscillator frequency input.
- Pin 18. No connection.
- Pin 19. No connection.
- Pin 20. Tennis game select. When grounded, this pin places the chip in the tennis game format.
- Pin 21. Hockey game select. When grounded, this pin places the chip in the hockey game format.
- Pin 22. Handball game select. When grounded, this pin places the chip in the handball format.
- Pin 23. Practice game select. When grounded, this pin places the chip in the practice game format.
- Pin 24. Score and field video output. This output provides on-screen scoring and the boundaries of each game.
- Pin 25. Reset input. When this pin is grounded, the TV screen loses all video and sync signals. When opened the chip is reset for a new game.
- Pin 26. No connection.
- Pin 27. Audio. This pin must be connected to Pin 3.
- Pin 28. No connection.

## CHIP CONTROL FUNCTION

The reset function is performed by half of IC Z1 (Fig. 2-5). Notice that the output of pin 13 (Z1) is connected to the reset input pin 25 of game chip Z3. Pin 13 of Z1 is normally high (Vc) since pins 9, 10, 11, and 12 are normally held low (ground) by R6. When switch A3S1 is pressed (upon reset), Vcc is fed to R6, which causes output pin 13 of Z1 to go low (ground). This low resets the game IC and brings the score to zero.

The slice (or angle) select is performed by switch S3, which is connected to pin 5 of chip Z3. When switch S3 is opened, 20° angles are provided. When switch S3 is closed, 20° and 40° angles are possible. The ball speed select is performed by switch S5. When switch S5 is opened, a slow or normal ball speed is selected by pin 7 of Z3. When S5 is closed, a ground is applied to pin 7 of Z3, which doubles the ball speed. The paddle size select is performed by switch S4. When switch S4 is open, a large paddle is selected. When S4 is closed, a smaller (half-size) paddle is selected.

The game select switch is S2. This switch connects a ground to one of the four game select pins of Z3. Only one of the four games may be selected at any time. Switch S1 (Fig. 2-6) is the channel select device. This switch feeds power to

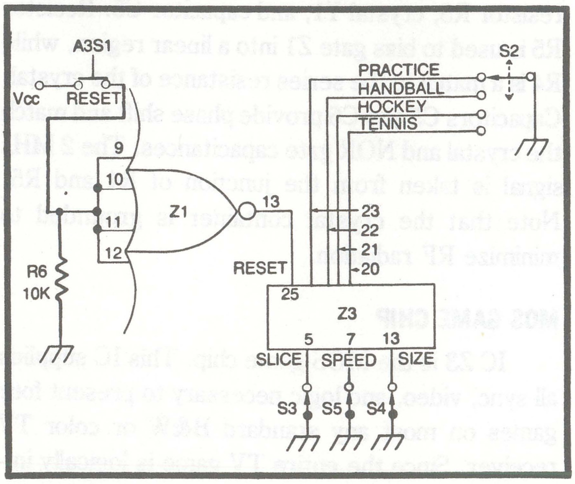



Fig. 2-5. Simplified schematic of the control functions for the 0-3051.

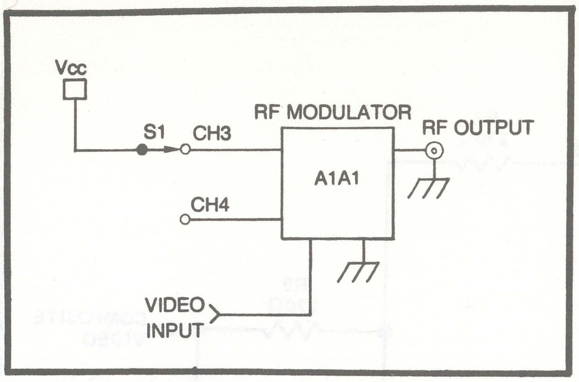



Fig. 2-6. Simplified schematic of the channel change circuit in the 60-3051 video game.

the modulator and also determines the TV channel number.

## AUDIO AMPLIFIER

The audio output of the game chip is at pin 3 of Z3 (Fig. 2-7). This pin is connected to resistor R3, which limits the current into the base of transistor Q2. When audio is generated at pin 3 of Z3, transistor Q2 conducts on each positive swing of the tone burst. When Q2 turns on, it allows unregulated DC power to flow through the speaker, current limiting resistor R2 and transistor Q2 to ground. Transistor Q2, of course, allows the low-level tone burst from the game chip to be heard at the speaker. When no sound is produced, pin 3 of Z3 is at ground and Q2 is off, blocking current flow through the speaker.

Note that pin 3 is also connected to pin 27 of Z3. This interconnection is necessary to prevent the audio from staying on whenever the ball strikes the left-hand wall. There is a logic defect in the game chip, so that when the ball hits the left boundary, the audio will stay on until the ball strikes something else or it goes off the screen to the right. By connecting pin 3 with pin 27, this audio glitch is corrected.

## VIDEO PROCESSING

Integrated circuit Z2 (Fig. 2-8, pins 9 – 13) is used as the mixer and inverting buffer for the horizontal and vertical sync signals which are outputted on pin 16 of Z3 and eventually applied to resistor R7. The left and right paddle video, the ball video, and the score and field video signals are mixed and inverted by the other half of Z2 and applied to resistor R8. The outputs of these two signals are then decreased in voltage amplitude by resistors R9 and R10, then fed onto the modulator.

The waveforms shown in Fig. 2-9 are an example of the type of information present in the circuit. The top waveform is applied to pins 9, 10, 11, and 12 of Z2. The center waveform is applied to pins 5, 4, 3, and 2 of Z2. The bottom waveform shows an example of what would be present at the junction of resistors R7, R8, and R9. This same would also be present at the junction of resistors R9 and R10, but at a different amplitude.

## MODULATOR

The modulator is a dual-channel, shielded, amplitude modulator mounted on a separate PC board. This device will be treated as a component without any theory of operation. Briefly, the modulator contains two separate LC oscillators that are selected by switching power to one oscillator or the other. The two oscillators are tuned for channel 3 or 4 in the TV broadcast bands (61.25 MHz and 67.25 MHz, respectively). Both of the oscillators are coupled to a diode modulator. The video signal, applied to the diode, increases and decreases the diode's forward conductance, thereby amplitude modulating the carrier frequency. The AM carrier output is fed from a coax connector. The output drive impedance is near 75Ω. The video input impedance is approximately 2K.

There are three inductors and two capacitors on modulator PC board A1. Inductors A1L1 and A1L2 and their associated capacitors, A1C1 and A1C2, help suppress spurious radiation into supply

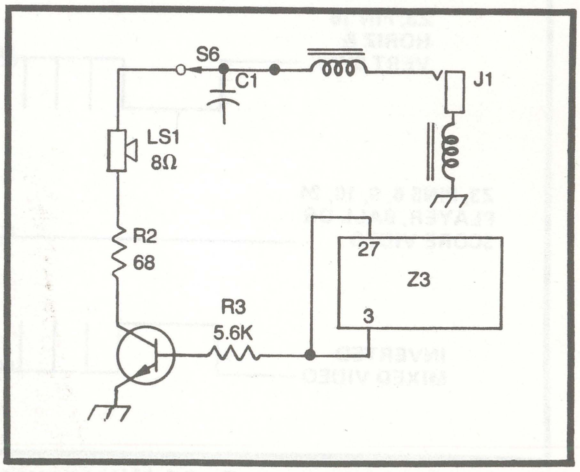



Fig. 2-7. Simplified audio output circuit of the 60-3051.

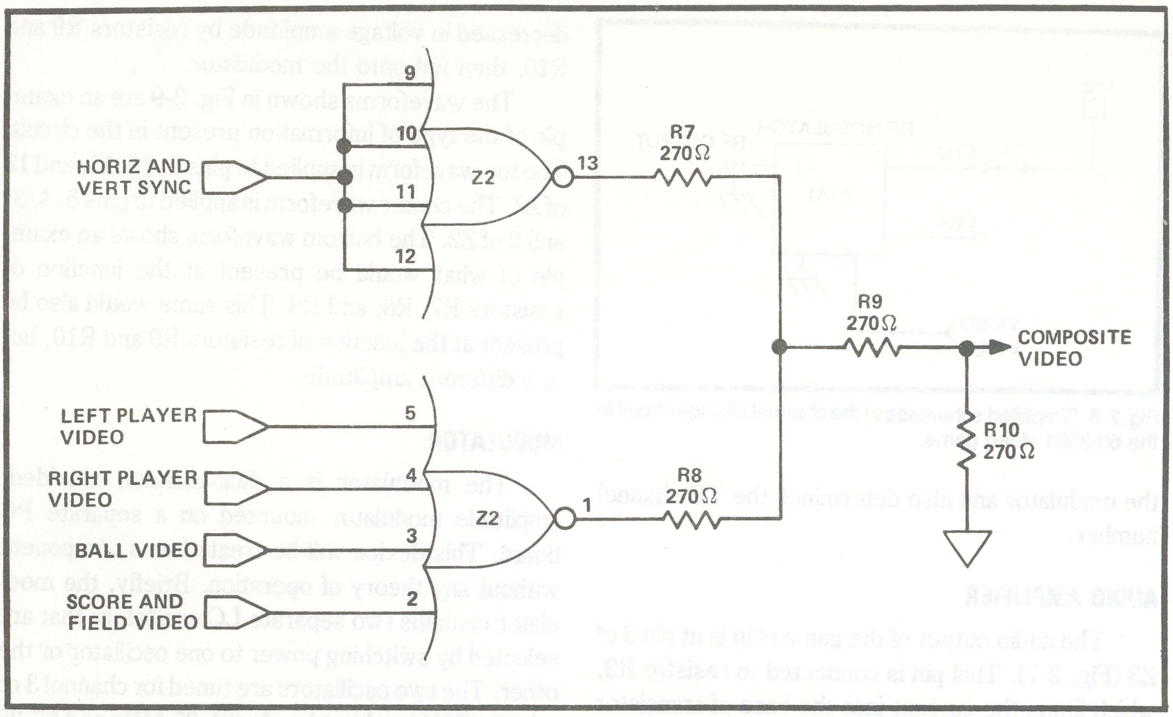



Fig. 2-8. Simplified schematic of the video processing circuitry in the 60-3051.

lines from the modulator. Inductor A1L3 in the video line does a similar job, but more importantly, it prevents oscillator harmonics from being modulated and radiated.

## ANTENNA SWITCH BOX

The switch box is connected to the TV set via the 300Ω input (Fig. 2-10). The antenna lead is then attached to the switch box. The game output cable is also connected to the box. A switch is used to select either the game signal or TV incoming signal, but not both. This switch provides 60 dB of isolation between the game signal and the TV antenna in keeping with FCC regulations. The game coax is connected to balun coil A4T1. This coil matches the modulator's 75Ω output impedance to the set's 300Ω antenna input. The output to the TV is connected to the wiper of the isolating switch. This switch provides 60 dB of isolation between the game and TV signals. This means that a signal on the

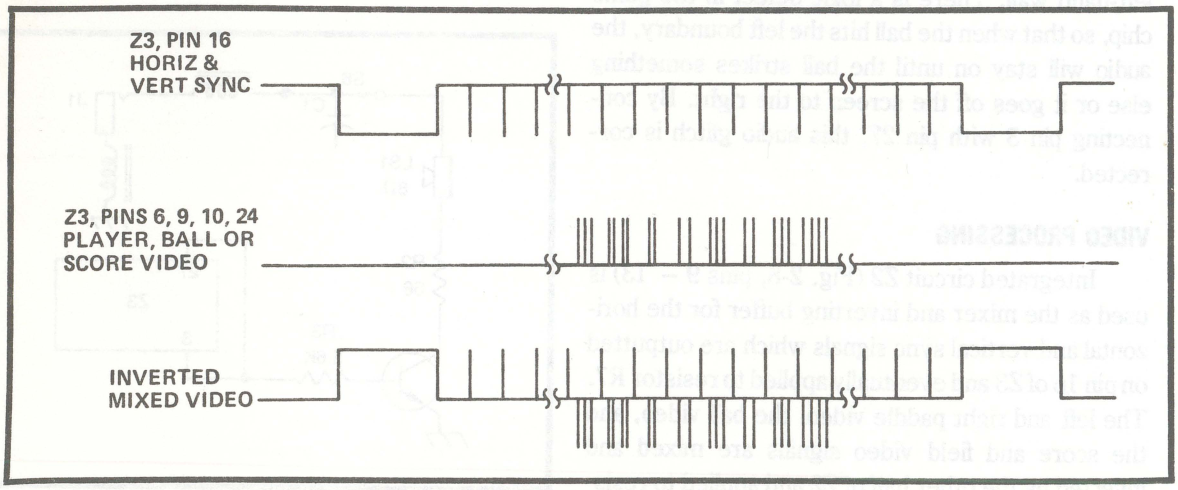



Fig. 2-9. Video processing waveforms of the 60-3051.

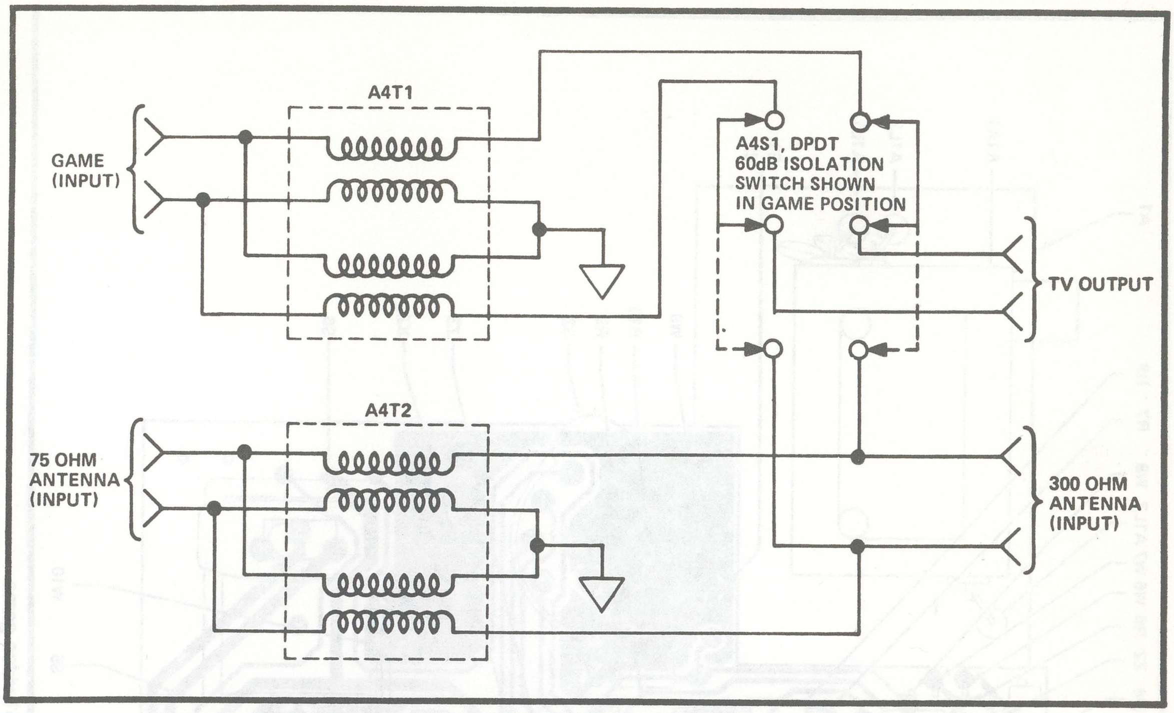



Fig. 2-10. Schematic diagram of the antenna switch box used in the 60-3051 video game.

selected terminal will be 1000 times greater than the signal on the open terminal. Balun coil A4T2 matches a 75Ω antenna system to a 300Ω TV input as shown on the schematic. The external antenna can never be directly connected to the game input.

## REMOTE PADDLE CONTROLS

An RC timing network (Fig. 2-11) is formed for each paddle. Components A3R1, R12, and C9 form the right paddle and components A2R1, R11, and C8 form the left paddle. When the network is connected to the Z3 inputs, a low duty cycle pulse discharges the capacitors (C8 or C9) 60 times a second, or 60 pps (pulses per second). The time it takes for the capacitor to charge back to some value fixed inside Z3 determines the paddle position on the screen. When the wiper of either A3R1 or A2R1 is away from the Vcc connection, the RC time constant is at its maximum, and the paddles are below the screen. When the wiper is at the opposite side, the time constant is at its minimum and the paddles are above the screen.

## GAME TROUBLESHOOTING

Refer to Fig. 2-12 during the following procedures for the location of test points, adjustments, and components. The overall schematic diagram is shown in Fig. 2-13. Test points are noted on the schematic by numbers enclosed in stars. A voltage and frequency chart for expected readings at various test points throughout the game is shown in Fig. 2-14. These voltage measurements should be taken with a high-impedance voltmeter, preferably a digital type. When making frequency measurements, be sure that the frequency counter does not load the circuit or detune it. Couple the signal through a 3 pF capacitor. Some of the voltages in Fig. 2-14 are peak-to-peak (P-P) voltages. Some voltmeters can measure peak-to-peak voltages, but they are best measured on an oscilloscope. Calibration of the oscilloscope is very important to obtain an accurate

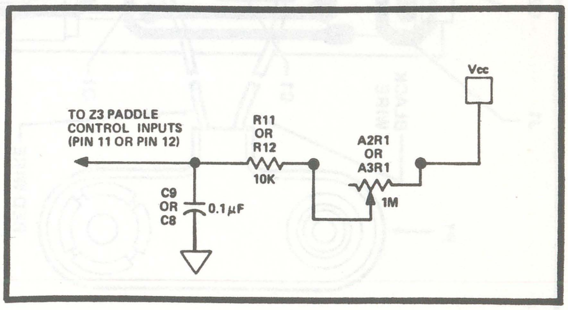



Fig. 2-11. Simplified circuit diagram of a remote paddle used in the 60-3051.

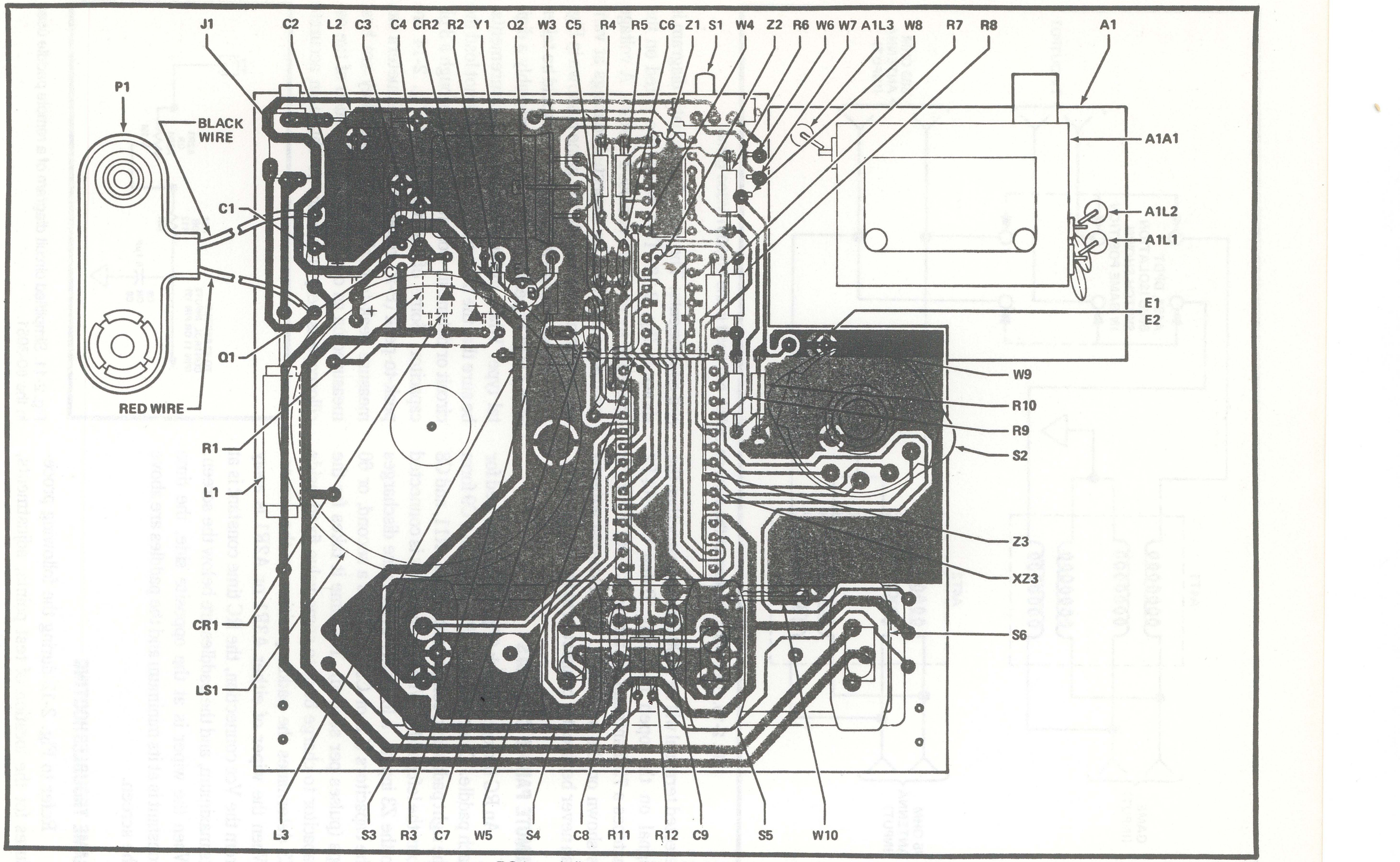


Fig. 2-12. PC board diagram of the 60-3051 video game.

measurement. Peak-to-peak waveforms are usually measured on an oscilloscope using either a direct probe or a 10:1 probe, depending on the application. Check your owner's manual before making these measurements. Representations of some of these waveforms are shown in Fig. 2-15.

The following test instruments are required to troubleshoot the TV game.

- Triggered-sweep oscilloscope (30–50 MHz) with low-capacitance probe.
- Digital voltmeter.
- Frequency counter (optional).

### Power Supply

If the game will not operate at all, video or audio, then the power supply should be checked first. Apply 9V DC to the input and check for 6.5V DC at TP5. If voltage at TP5 is okay, then move on to the oscillator circuit. If voltage at TP5 is not correct, check for 7.1V DC at TP4. If an improper voltage is found, suspect faulty diodes CR1 and CR2. Check for correct installation of diodes. Also check capacitor C2 for proper polarity in circuit and for shorts. If TP4 checks good, then transistor Q1 is probably at fault.

Transistor Q1 will be destroyed (open) if there is a short on the Vcc line, even momentarily. If the fault is not found, continue to trace back, checking TP3 (unregulated power to the audio and regulator section), switch S6, TP2, TP1, and finally jack J1. Jack J1 should disconnect the batteries when the AC adapter's power plug is inserted and apply battery power when it is removed.

The value of capacitor C2 (220 $\mu$F) is multiplied by the gain of transistor Q1 (100) and a much larger capacitor is effectively connected at TP5. If this capacitor were to open, little effect will be noticed when the game is battery powered; but, with an AC adapter plugged into J1, hum bars might be seen on the TV screen. Hum bars will show up as two dark bands that may drift up or down the screen. These bars are caused by ripple voltage from the rectified AC in the adapter, distorting the video waveform. Even though the adapter has a filter capacitor, about 0.5V of ripple is still present. The action of capacitor C2 and transistor Q1 helps eliminate ripple, reducing it to less than 0.01V. Note that hum bars can also be caused by faulty filters in the TV set's power supply.

Hum bars may be tolerable on the screen while viewing TV programs, but when the TV game is on, with its straight vertical and horizontal lines, the hum bars may become objectionable. Usually, ripple will cause distortion of the vertical lines by putting a gradual bend in the lines, or the ball may appear to suddenly curve around some invisible object.

### Crystal Oscillator

TP8 should be almost a square wave of 2.01216 MHz. The CMOS gate used as the active portion of the oscillator is operating as a linear device and not as a digital device. Thus, the almost square wave will have sloping rise and fall times, and slightly rounded logic levels. Instruments used to measure the frequency or analyze the waveform should have a high input impedance and less than 50 pF capacitance.

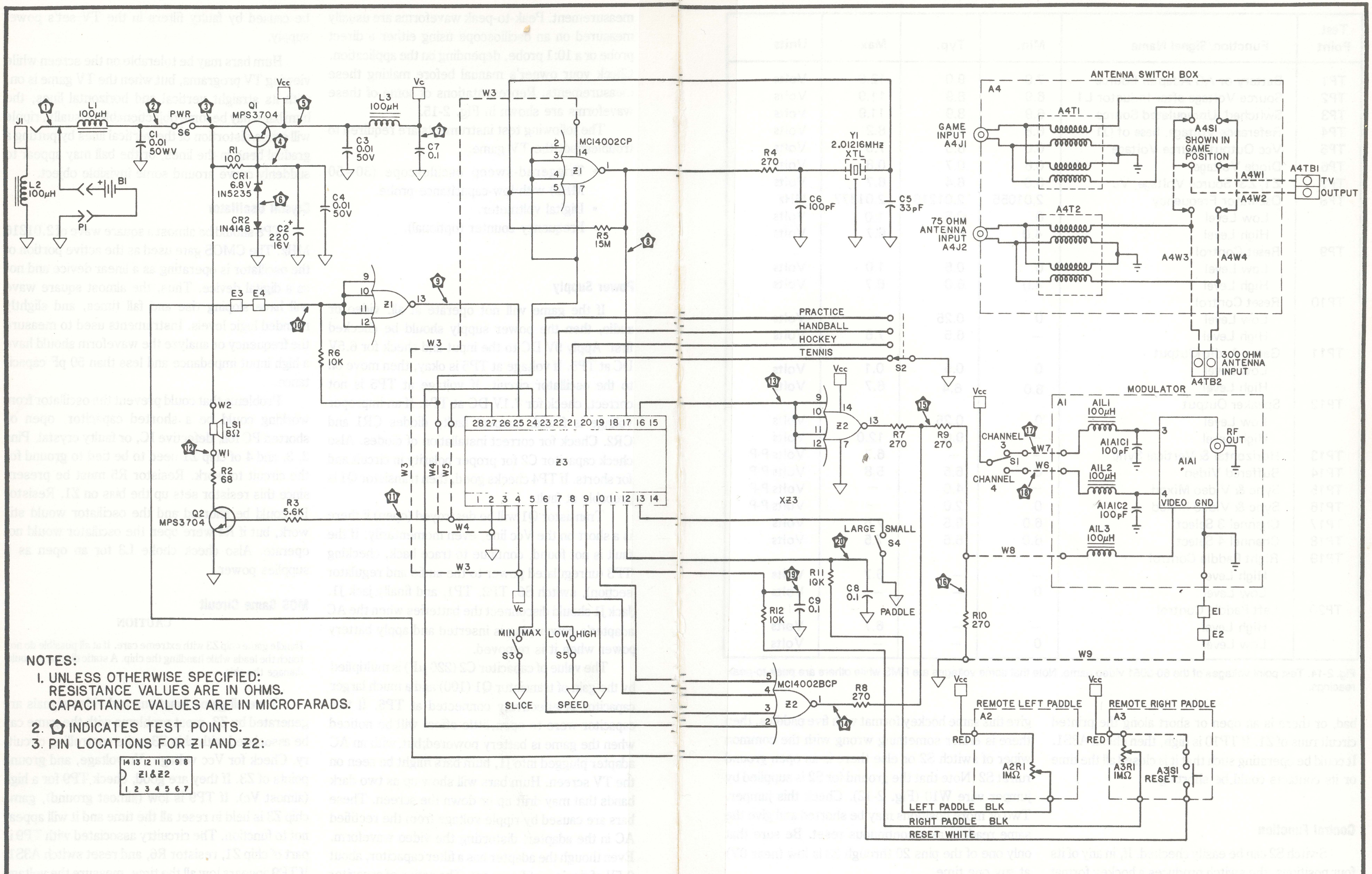
Problems that could prevent the oscillator from working could be a shorted capacitor, open or shorted PC foil, defective IC, or faulty crystal. Pins 2, 3, and 4 of chip Z1 need to be tied to ground for the circuit to work. Resistor R5 must be present since this resistor sets up the bias on Z1. Resistor R4 could be shorted and the oscillator would still work, but if R4 were open the oscillator would not operate. Also check choke L3 for an open as it supplies power.

### MOS Game Circuit

**CAUTION**

Handle game chip Z3 with extreme care. If at all possible do not touch the leads while handling the chip. A static discharge could damage the chip.

Since all game functions and video signals are generated by Z3, most problems with the game can be associated with chip Z3 or its controlling circuitry. Check for Vcc voltage, Vc voltage, and ground points of Z3. If they are good, check TP9 for a high (almost Vc). If TP9 is low (almost ground), game chip Z3 is held in reset all the time and it will appear not to function. The circuitry associated with TP9 is part of chip Z1, resistor R6, and reset switch A3S1. If TP9 appears low all the time, measure the voltage at TP10; use a high-impedance voltmeter or an oscilloscope. If this point is low, then either Z1 is




NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTANCE VALUES ARE IN OHMS.
   CAPACITANCE VALUES ARE IN MICROFARADS.
2. ✪ INDICATES TEST POINTS.
3. PIN LOCATIONS FOR Z1 AND Z2:

Fig. 2-13. Overall schematic diagram of the 60-3051 video game.

| Test Point | Function/Signal Name | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| TP1 | Battery or AC Adapter Source | 7.0 | 9.0 | 12.0 | Volts |
| TP2 | Source Voltage after Inductor L1 | 6.9 | 8.9 | 11.9 | Volts |
| TP3 | Switched, Unregulated Source | 6.9 | 8.9 | 11.9 | Volts |
| TP4 | Reference Voltage, base of Q1 | 6.8 | 7.5 | 8.2 | Volts |
| TP5 | Vcc Output Source Voltage | 6.0 | 6.5 | 7.5 | Volts |
| TP6 | Diode Voltage | 0.6 | 0.7 | 0.8 | Volts |
| TP7 | Z1, Z3, Source Voltage, Vc | 6.0 | 6.4 | 6.7 | Volts |
| TP8 | Oscillator Frequency | 2.01055 | 2.01216 | 2.01377 | MHz |
| | Low Level | 0 | 0.5 | 1.0 | Volts |
| | High Level | 4.0 | 6.0 | 6.7 | Volts |
| TP9 | Reset Control | | | | |
| | Low Level | 0 | 0.5 | 1.0 | Volts |
| | High Level | 4.0 | 6.0 | 6.7 | Volts |
| TP10 | Reset Control | | | | |
| | Low Level | 0 | 0.25 | – | Volts |
| | High Level | – | 6.5 | 7.5 | Volts |
| TP11 | Game Audio Output | | | | |
| | Low Level | 0 | 0.5 | 0.1 | Volts |
| | High Level | 6.0 | 6.4 | 6.7 | Volts |
| TP12 | Speaker Output | | | | |
| | Low Level | 0 | 0.25 | – | Volts |
| | High Level | – | 9.0 | 12.0 | Volts |
| TP13 | Horizontal & Vertical Sync | – | – | 6.7 | Volts P-P |
| TP14 | Buffered Video | 0 | 5.5 | 5.8 | Volts P-P |
| TP15 | Sync & Video Mixed | – | 4.0 | – | Volts P-P |
| TP16 | Sync & Video Mixed | 0 | 2.0 | – | Volts P-P |
| TP17 | Channel 3 Select | 6.0 | 6.5 | 7.5 | Volts |
| TP18 | Channel 4 Select | 6.0 | 6.5 | 7.5 | Volts |
| TP19 | Right Paddle Control | | | | |
| | High Level | – | – | 6.7 | Volts |
| | Low Level | 0 | – | – | Volts |
| TP20 | Left Paddle Control | | | | |
| | High Level | – | – | 6.7 | Volts |
| | Low Level | 0 | – | – | Volts |

**Fig. 2-14. Test point voltages of the 60-3051 video game. Note that some voltages are RMS while others are peak-to-peak readings.**

bad, or there is an open or short along the printed circuit runs of Z1. If TP10 is high, then check A3S1. It could be operating such that it is closed all the time or its contacts could be shorting.

## Control Function

Switch S2 can be easily checked. If, in any of its four positions, the switch produces a hockey format with five paddles, it indicates that a particular switch position is opened. Of course, if all game positions give this same hockey format with five paddles, then there is either something wrong with the common wiper of switch S2 or else there is an open ground run at S2. Note that the ground for S2 is supplied by jumper wire W10 (Fig. 2-12). Check this jumper. Two or more positions may be shorted and give the same readout as a continuous reset. Be sure that only one of the pins 20 through 23 is low (near 0V) at any one time.

Slice, speed, and paddle switches are SPDT switches that make or break contact with pins of Z3.

Troubleshooting these switches should not be difficult. Either the switch is defective, or else there is a PC board foil problem.

The modulator channel select switch (S1) at the rear of the board is an SPDT switch. It should supply Vcc to one of the modulator inputs. The other input should be close to ground. A short between TP17 and TP18 would not affect the apparent operation of the TV game. If you receive the game equally well on channels 1, 3, and 4, then it's safe to assume that TP17 and TP18 are shorted together.

## Audio Amplifier

The audio output from game chip Z3 is at pin 3, or TP11. The tone burst goes from ground level to Vc level. If you see tone action at TP11 and the speaker is not beeping, check for proper operation of transistor Q2. If transistor Q2 is okay, check for poor solder joints around resistor R2. If resistor R2 is also good, check speaker LS1 and associated PC connections. Notice that the audio network receives its power from the unregulated side of Q1.

## Video Processing

Video processor NOR gate Z2 inverts, mixes, and buffers all video and sync signals for the modulator. Sync signals at TP13 are easily seen with an oscilloscope, but the video at TP14 is difficult to find unless you have a wide-band triggered-sweep scope. The best test equipment (indicator) for this section is a TV receiver. Since left and right players (paddle), ball video, and score and field video are all outputted on separate pins of Z3, it is a simple matter to determine what pin is opened or shorted if something is missing from the screen.

An open input to Z2 would be harder to isolate than a shorted (grounded) pin. Let's consider that pin 5 of Z2 (left player video input) is shorted to ground. The TV screen will show a normal video pattern, except the left player paddle will be miss-

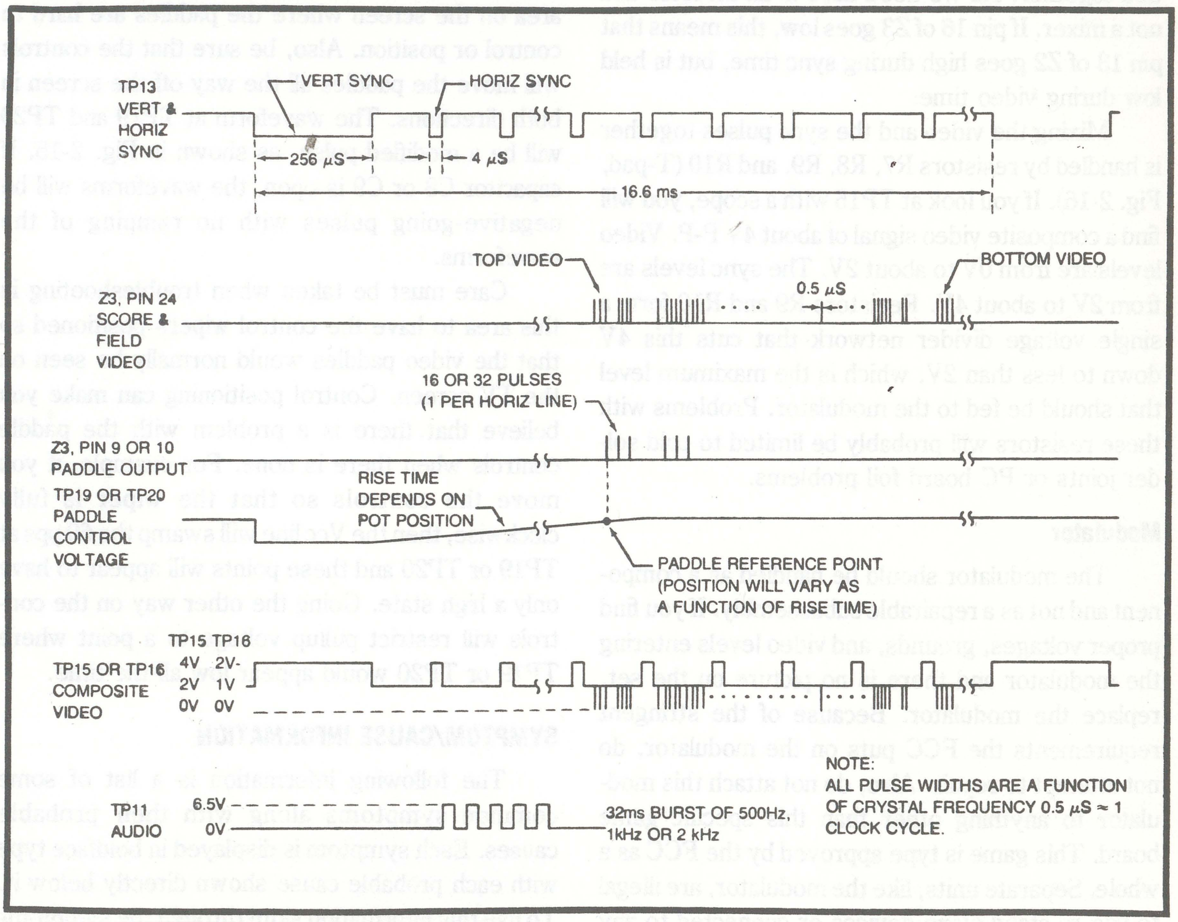



Fig. 2-15. Game chip Z3 waveforms. See Fig. 2-14 for additional voltage information.

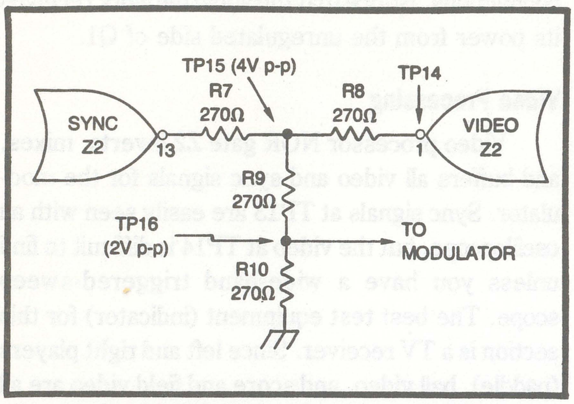



Fig. 2-16. Simplified diagram of T-pad mixer formed by resistors R7, R8, R9, and R10.

ing. But, if pin 5 of Z2 is opened (or shorted to Vcc), then the TV screen will appear to be in sync but there will be no video at all. An open or short to Vcc on pins 2, 3, or 4 of Z2 would cause this same blank field (raster).

Note that the sync half of Z2 has all of its inputs tied together. All we need here is an inverter and not a mixer. If pin 16 of Z3 goes low, this means that pin 13 of Z2 goes high during sync time, but is held low during video time.

Mixing the video and the sync pulses together is handled by resistors R7, R8, R9, and R10 (T-pad, Fig. 2-16). If you look at TP15 with a scope, you will find a composite video signal of about 4V P-P. Video levels are from 0V to about 2V. The sync levels are from 2V to about 4V. Resistors R9 and R10 form a single voltage divider network that cuts this 4V down to less than 2V, which is the maximum level that should be fed to the modulator. Problems with these resistors will probably be limited to cold solder joints or PC board foil problems.

### Modulator

The modulator should be handled as a component and not as a repairable subassembly. If you find proper voltages, grounds, and video levels entering the modulator and there is no picture on the set, replace the modulator. Because of the stringent requirements the FCC puts on the modulator, do not attempt to repair. Also, do not attach this modulator to anything other than this specific game board. This game is type approved by the FCC as a whole. Separate units, like the modulator, are illegal to use as stand-alone devices or connected to any other device.

### Antenna Switch Box

Except for faulty switch and plugs, about the only problem in the switch box (Fig. 2-17) should be loose connections. Make sure all devices have good solder connections and that all hardware is tight and making good grounds. Make sure that the internal shielding within the box is not shorting any wires. Also, check the rivets holding the shielding, terminal strip, and isolation switch for tightness. The best test for the switch box is actually connecting it to a TV monitor and feeding video into it. Check the picture for sharpness and lack of snow. A weak signal will cause snow.

### Remote Paddle Controls

Problems with the remote paddle controls are usually limited to wiring problems within the cables and electrical or mechanical problems with the pots. Electrical problems may show up by either suddenly disappearing paddles, or there may be a no-man's area on the screen where the paddles are hard to control or position. Also, be sure that the controls will move the paddles all the way off the screen in both directions. The waveform at TP19 and TP20 will be a modified pulse, as shown in Fig. 2-15. If capacitor C8 or C9 is open, the waveforms will be negative-going pulses with no ramping of the waveforms.

Care must be taken when troubleshooting in this area to have the control wipers positioned so that the video paddles would normally be seen on the TV screen. Control positioning can make you believe that there is a problem with the paddle controls when there is none. For example, if you move the controls so that the wiper is fully clockwise, then the Vcc line will swamp the 60 pps at TP19 or TP20 and these points will appear to have only a high state. Going the other way on the controls will restrict pullup voltage to a point where TP19 or TP20 would appear low all the time.

## SYMPTOM/CAUSE INFORMATION

The following information is a list of some common symptoms along with their probable causes. Each symptom is displayed in boldface type with each probable cause shown directly below it. To use this information skim through the symptoms to find the one that best fits the problem at hand.

Then, one by one, check each of the components or perform each of the tests indicated.

### Audio Okay but No Picture

- Antenna switch box not connected properly.
- Broken coax to or in antenna switch box.
- Defective switch A4S1.
- Switch A4S1 in wrong position.
- Defective Z2.
- Open or shorted PC connector.
- Defective modulator.

### Audio Okay but Picture Fades

- Defective video mixer Z2.

### Paddle Jerks an Inch When Speaker Beeps

- Check power supply.
- Weak batteries.

- Short in audio section.
- Intermittent choke L1 or L2.
- Shorted diode CR2.
- Defective regulator Q1.

### Weak Audio but Good Picture

- Resistor R2 changed value.
- Transistor Q2 defective.
- Defective speaker LS1.

### No Audio or Video

- Open regulator Q1.
- Shorted capacitor C2.
- Shorted diode CR1.
- Open switch S6 or choke L1.
- Broken jack J1.
- Short in PC board foil.
- Shorted capacitor C5 or C6.
- Open input to chip Z3.

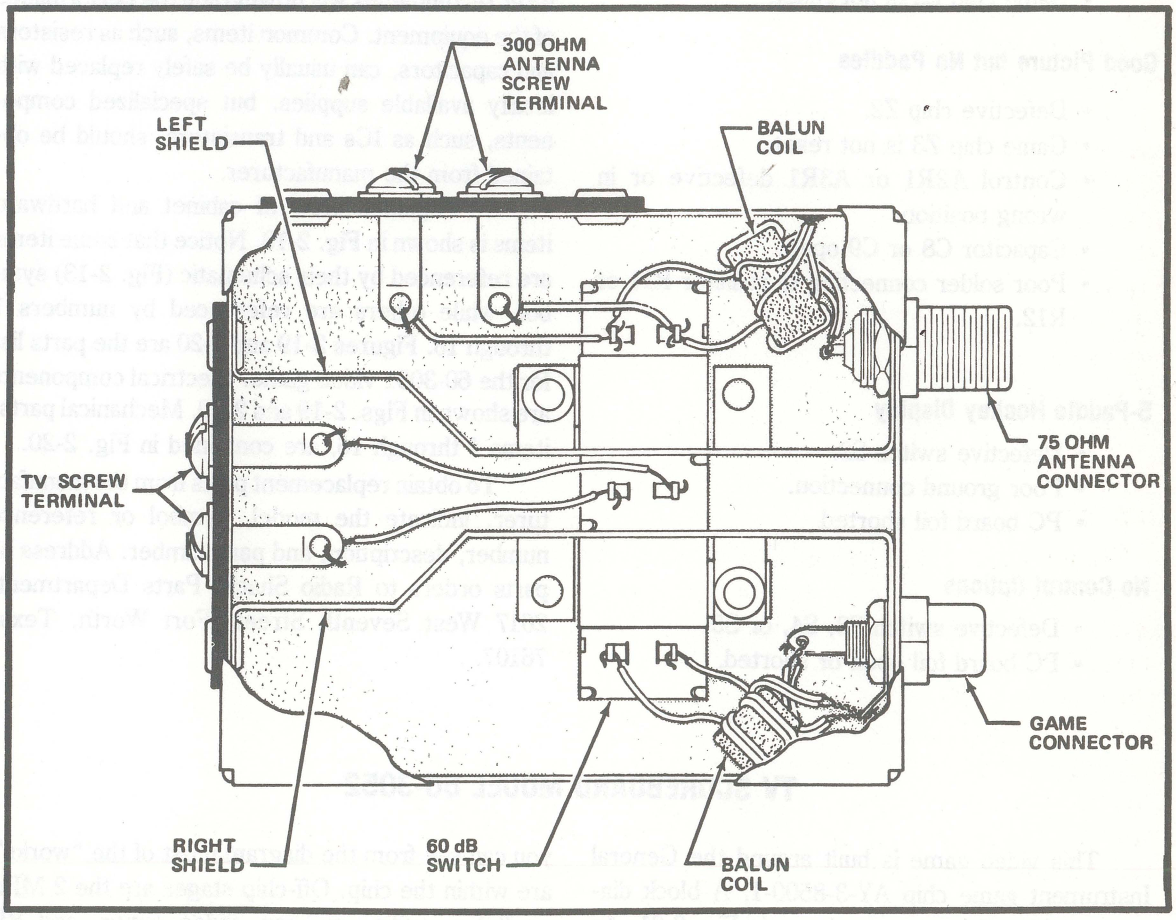



Fig. 2-17. Layout of antenna switch box.

- Defective oscillator Z1 or crystal Y1.
- Poor solder joint.
- Broken or missing jumper wire.
- Switch A3S1 shorted.
- Game chip Z3 defective.

### Picture Good but Audio Dead

- Open or shorted amplifier Q2.
- Open speaker LS1.
- Poor solder joint on PC board.

### Hum Bars Present When Using AC Adaptor

- Open electrolytic capacitor C2.
- Defective regulator Q1.
- Defective zener CR1.

### No Ball, Score, or Field

- Defective chip Z2.
- Shorted input to Z2.
- Game chip Z3 is not reset.

### Good Picture but No Paddles

- Defective chip Z2.
- Game chip Z3 is not reset.
- Control A2R1 or A3R1 defective or in wrong position.
- Capacitor C8 or C9 open.
- Poor solder connection to resistor R11 or R12.

### 5-Paddle Hockey Display

- Defective switch S2.
- Poor ground connection.
- PC board foil shorted.

### No Control Options

- Defective switch S3, S4, or S5.
- PC board foil open or shorted.

### One Channel Okay but not the Other

- Defective switch S1.
- Defective modulator unit.

### Diagonal Lines Present in Picture

- Defective balun A4T1.
- Defective switch A4S1.
- Open ground connection.

### Excessive Audio After Rebound

- Missing jumper W5 between pins 3 and 27 of game chip Z3.

### Paddle Jitters at Random Rate

- Defective electrolytic capacitor C7.

### REPLACEMENT PARTS

It is very important to use the correct replacement when installing new parts in the video game. Using components other than what the manufacturer recommends will downgrade the performance of the equipment. Common items, such as resistors and capacitors, can usually be safely replaced with locally available supplies, but specialized components, such as ICs and transistors, should be obtained from the manufacturer.

An exploded view of cabinet and hardware items is shown in Fig. 2-18. Notice that some items are referenced by their schematic (Fig. 2-13) symbol, while others are referenced by numbers 1 through 16. Figures 2-19 and 2-20 are the parts list for the 60-3051 video game. Electrical components are shown in Figs. 2-19 and 2-20. Mechanical parts, items 1 through 16, are contained in Fig. 2-20.

To obtain replacement parts from the manufacturer, indicate the model, symbol or reference number, description, and part number. Address all parts orders to Radio Shack, Parts Department, 2617 West Seventh Street, Fort Worth, Texas 76107.

## TV SCOREBOARD MODEL 60-3052

This video game is built around the General Instrument game chip AY-3-8500-1. A block diagram of this video game is shown in Fig. 2-21. As you can see from the diagram most of the "works" are within the chip. Off-chip stages are the 2 MHz oscillator, audio amplifier, video mixer, and RF

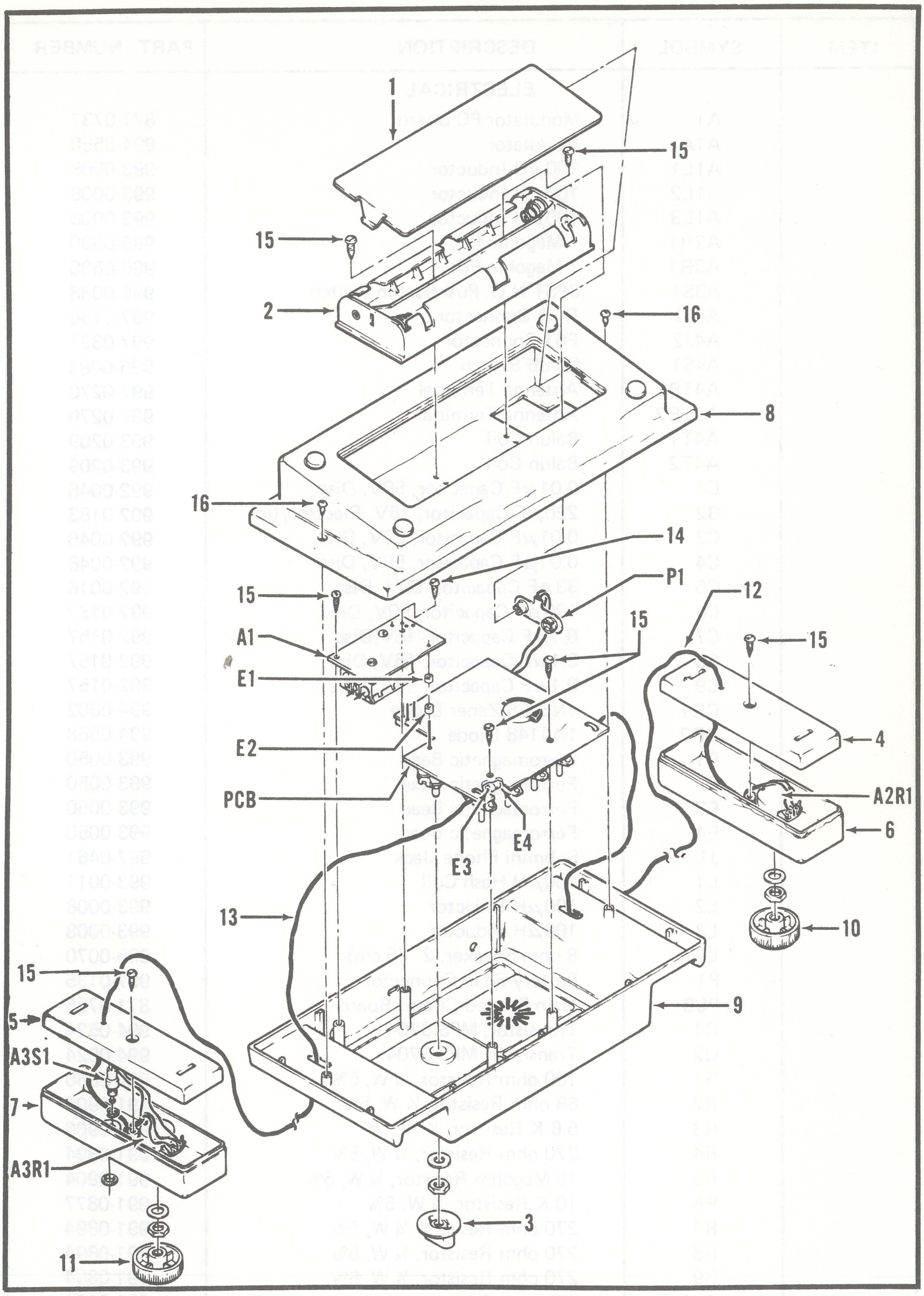



Fig. 2-18. Exploded view of cabinet and hardware.

| ITEM | SYMBOL | DESCRIPTION | PART NUMBER |
|---|---|---|---|
| | | **ELECTRICAL** | |
| | A1 | Modulator PC Board | 871-0737 |
| | A1A1 | Modulator | 994-0550 |
| | A1L1 | 100μH Inductor | 993-0008 |
| | A1L2 | 100μH Inductor | 993-0008 |
| | A1L3 | 100μH Inductor | 993-0008 |
| | A2R1 | 1 Megohm Pot | 996-0630 |
| | A3R1 | 1 Megohm Pot | 996-0630 |
| | A3S1 | SPST N.O. Pushbutton Switch | 996-0088 |
| | A4J1 | RCA Connector | 997-0136 |
| | A4J2 | F61 Connector | 997-0397 |
| | A4S1 | 60 dB Switch | 996-0083 |
| | A4TB1 | Antenna Terminal | 997-0270 |
| | A4TB2 | Antenna Terminal | 997-0270 |
| | A4T1 | Balun Coil | 993-0209 |
| | A4T2 | Balun Coil | 993-0209 |
| | C1 | 0.01μF Capacitor, 50V, Disc | 992-0046 |
| | C2 | 220μF Capacitor, 16V, Electrolytic | 992-0183 |
| | C3 | 0.01μF Capacitor, 50V, Disc | 992-0046 |
| | C4 | 0.01μF Capacitor, 50V, Disc | 992-0046 |
| | C5 | 33 pF Capacitor, 50V, Disc | 992-0016 |
| | C6 | 100 pF Capacitor, 50V, Disc | 992-0182 |
| | C7 | 0.1μF Capacitor, 16V,Disc | 992-0157 |
| | C8 | 0.1μF Capacitor, 16V, Disc | 992-0157 |
| | C9 | 0.1μF Capacitor, 16V, Disc | 992-0157 |
| | CR1 | 1N5235 Zener Diode | 994-0602 |
| | CR2 | 1N4148 Diode | 994-0588 |
| | E1 | Ferromagnetic Bead | 993-0050 |
| | E2 | Ferromagnetic Bead | 993-0050 |
| | E3 | Ferromagnetic Bead | 993-0050 |
| | E4 | Ferromagnetic Bead | 993-0050 |
| | J1 | Submini Phone Jack | 997-0461 |
| | L1 | 100μH Hash Coil | 993-0011 |
| | L2 | 100μH Inductor | 993-0008 |
| | L3 | 100μH Inductor | 993-0008 |
| | LS1 | 8 ohm Speaker, 2" (5 cm) | 995-0070 |
| | P1 | Battery Snap Connector | 997-0135 |
| | PCB | Main Printed Circuit Board | 871-0735 |
| | Q1 | Transistor, MPS-3704 | 994-0524 |
| | Q2 | Transistor, MPS-3704 | 994-0524 |
| | R1 | 100 ohm Resistor, ¼ W, 5% | 991-0860 |
| | R2 | 68 ohm Resistor, ¼ W, 5% | 991-0905 |
| | R3 | 5.6 K Resistor, ¼ W, 5% | 991-0906 |
| | R4 | 270 ohm Resistor, ¼ W, 5% | 991-0894 |
| | R5 | 15 Megohm Resistor, ¼ W, 5% | 991-0904 |
| | R6 | 10 K Resistor, ¼ W, 5% | 991-0877 |
| | R7 | 270 ohm Resistor, ¼ W, 5% | 991-0894 |
| | R8 | 270 ohm Resistor, ¼ W, 5% | 991-0894 |
| | R9 | 270 ohm Resistor, ¼ W, 5% | 991-0894 |
| | R10 | 270 ohm Resistor, ¼ W, 5% | 991-0894 |

**Fig. 2-19. Parts list for the 60-3051 (1 of 2).**

| ITEM | SYMBOL | DESCRIPTION | PART NUMBER |
|---|---|---|---|
| | R11 | 10 K Resistor, ¼ W, 5% | 991-0877 |
| | R12 | 10 K Resistor, ¼ W, 5% | 991-0877 |
| | S1 | SPDT Slide Switch (Channel Select) | 966-0086 |
| | S2 | SP4T Rotary Switch (Game Select) | 996-0087 |
| | S3 | SPST (Black) Switch (Slice Control) | 996-0084 |
| | S4 | SPST (Black) Switch (Paddle Size Control) | 996-0084 |
| | S5 | SPST (Black) Switch (Speed Control) | 996-0084 |
| | S6 | SPST (Red) Switch (Power) | 996-0085 |
| | Socket | 28 Pin IC Socket | 994-0479 |
| | Y1 | 2.01216 MHz Crystal | 994-0151 |
| | Z1 | 4-Input NOR Gate, MC14002CP | 994-0486 |
| | Z2 | 4-Input NOR Gate, MC14002BCP | 994-0489 |
| | Z3 | Game Integrated Circuit, AY-3-8500-1 | 994-0487 |
| | | **MECHANICAL** | |
| 1 | | Battery Door | 801-0260 |
| 2 | | Battery Holder | 997-0129 |
| 3 | | Game Select Knob | 998-0419 |
| 4 | | Hand Control, lower (left) | 801-0259 |
| 5 | | Hand Control, lower (right) | 801-0259 |
| 6 | | Hand Control, upper (left) | 801-0258 |
| 7 | | Hand Control, upper (right) | 801-0257 |
| 8 | | Main Lower Case | 801-0256 |
| 9 | | Main Upper Case | 801-0255 |
| 10 | | Paddle Control Knob (left) | 998-0418 |
| 11 | | Paddle Control Knob (right) | 998-0418 |
| 12 | | 4′ of 3 Cond Cable (left) | 997-0432 |
| 13 | | 4′ of 3 Cond Cable (right) | 997-0434 |
| 14 | | 1/2″ TC Screw | 998-0042 |
| 15 | | 3/8″ TC Screw | 998-0421 |
| 16 | | 1/4″ TC Screw | 998-0428 |
| | | AC Adapter | 993-0910 |
| | | Antenna Box | 801-0262 |
| | | Antenna Box Cover | 801-0261 |
| | | Antenna Box Label | 990-1463 |
| | | Antenna Box Left Shield | 801-0264 |
| | | Antenna Box Right Shield | 801-0263 |
| | | FCC Label | 990-1464 |
| | | Hook and Loop Fastener | 997-0172 |
| | | Owner's Manual | 990-0877 |
| | | Metric Screw | 998-0422 |
| | | Modified Grommet | 994-0347 |
| | | Pop Rivet | 998-0427 |
| | | Rubber Foot | 998-0416 |
| | | Switch Mask | 996-0094 |
| | | Tie Wrap | 997-0421 |
| | | Twin Lead With Lugs | 997-0431 |
| | | 12′ of Coax Cable With Plugs | 997-0430 |
| | | No. 4 Washers | 998-0095 |
| | | Switch Support | 801-0277 |

**Fig. 2-20. Parts list for the 60-3051 (2 of 2).**

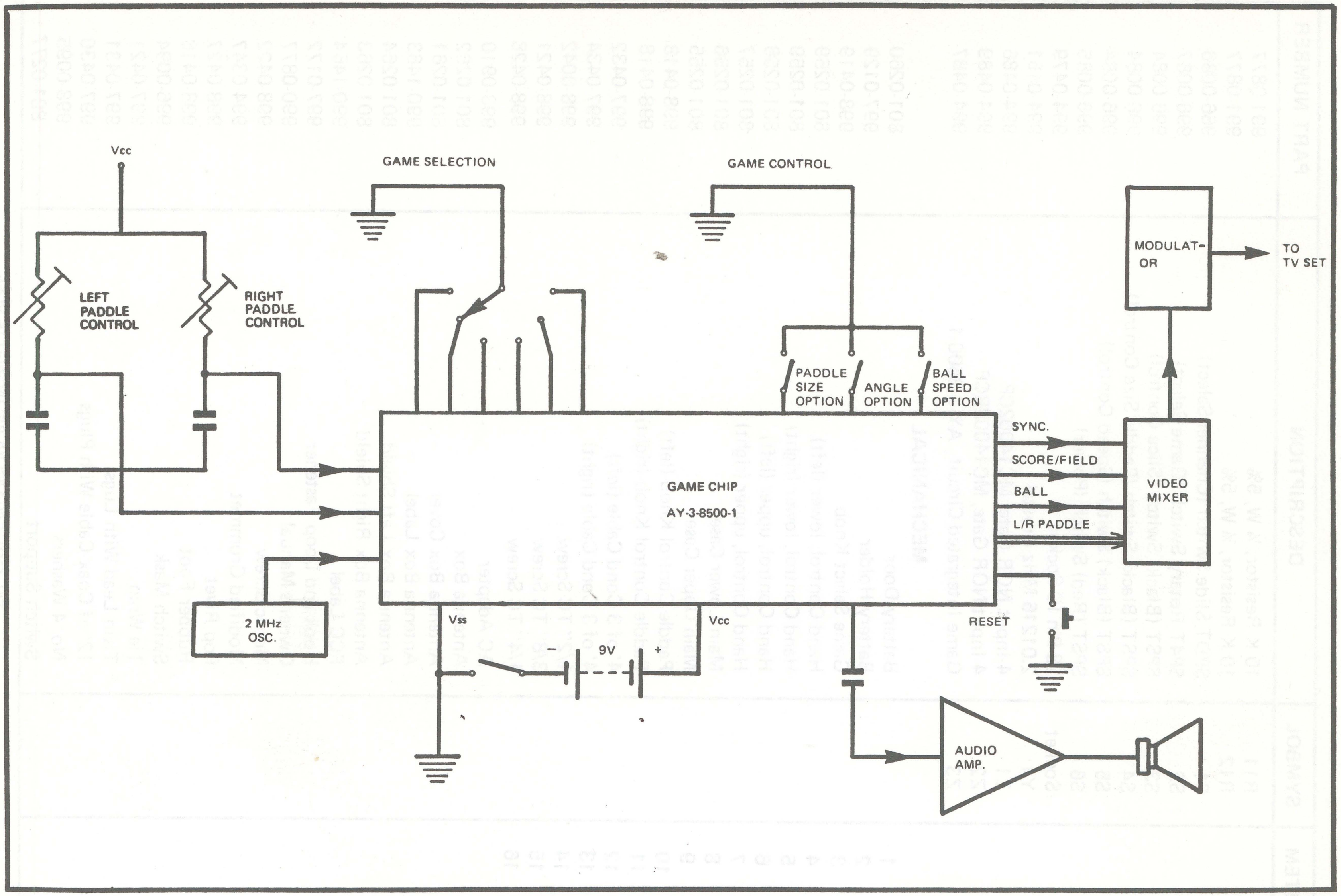



Fig. 2-21. Block diagram of the 60-3052 video game.

modulator. The remaining circuits are control functions for the game chip, such as left and right paddles.

## GAME SPECIFICATIONS

| | |
|---|---|
| RF output | 600-1500$\mu$V at 300Ω |
| Channel 3 output | 61.25 MHz ±500 kHz |
| Channel 4 output | 67.25 MHz ±500 kHz |
| Horz. sync frequency | 15.734 kHz |
| Supply voltage | |
| Battery | 6 C-cell type |
| AC adaptor | 9V at 110 mA |
| Current drain | 80 – 100 mA |

## GAME ADJUSTMENTS

Test equipment required to perform service adjustments is as follows:

- 5 MHz frequency counter, sensitivity 50 mV, 4 digits.
- RF millivoltmeter capable of reading up to 80 MHz.
- Multimeter of at least 10K Ω/V sensitivity.
- Regulated 9V DC power supply at 150 mA.
- TV receiver tuned to channel 3 or 4.
- Low-leakage soldering iron.

**CAUTION**

Almost all MOS LSI chips are extremely susceptible to damage from static electricity (or AC leakage). When working with units having MOS chips, use only a completely isolated soldering iron. The best bet is a rechargeable, battery-operated iron which will not have any AC leakage and thus not damage the IC.

If the game chip is defective, carefully remove it (desoldering tool, etc.). When replacing the chip, be sure to position the pins properly with dot next to pin 1. Do not handle the IC by its pins. Be sure the power is off when IC is installed.

LSI chips have been tested and selected by voltage range. You may need to change the voltage regulator to compensate for the voltage of the IC.

### Setting the Voltage Regulator

Note the voltage indicated on the LSI chip (sticker on IC). Should the LSI chip be marked 7–9V, set VR3 (Fig. 2-22) to give an emitter voltage at Q4 that is 0.25V *higher* than the lower indicated voltage. In this case it would be 7.25V.

Other voltages can be set accordingly. Always maintain a working voltage for the LSI chip that is 0.25V higher than the minimum value indicated on the LSI sticker.

### Adjusting the Clock Frequency

The clock oscillator is fed from a regulated DC line (zener Z1). Hook up the frequency counter to the emitter of transistor Q2 with a 100K series resistor. See the test equipment setup in Fig. 2-23. Adjust the core of coil L1 to give a frequency of 15.734 kHz.

This clock frequency setting is very important for horizontal sync.

### Setting Up Channel Frequencies

Refer to Fig. 2-24 for proper equipment connections.

1. Set switch S7 to channel 4. Adjust the core of coil L5 for an RF output frequency of 67.25 MHz.
2. Now switch to channel 3. Adjust trimmer capacitor CT1 for an output frequency of 61.25 MHz using the RF millivoltmeter.
3. Check the voltage at the junction of R11-R13. It should be between 3.6V and 3.8V. This is important for the correct RF output level. The correct RF output level is 1000 to 1500 $\mu$V (300Ω).
4. After adjustments have been performed, check the operation with a TV set on channels 3 and 4 for correct frequency adjustments.

## TROUBLESHOOTING TIPS

**No Sound**—Check speaker, speaker leads, and output transistor Q1.

**No Clock Frequency**—Defective Q2 or open coil L1. Check zener Z1 if supply voltage is not present.

**No Voltage Regulation**—Defective transistor Q4 or zener Z2. Shorted or leaky capacitor C21 or C20. Intermittent contact in potentiometer VR3.

**No RF Voltage**—Broken wires to RF output jack. Defective Q3. Short in voltage supply line.

**Erratic Ball, Game, or Counting**—Low battery voltage. Check voltage regulator setting.

**One or More Games Do Not Work**—Defective rotary switch S6 or cold-solder joints. Defective LSI chip. Replace the game chip if faulty.

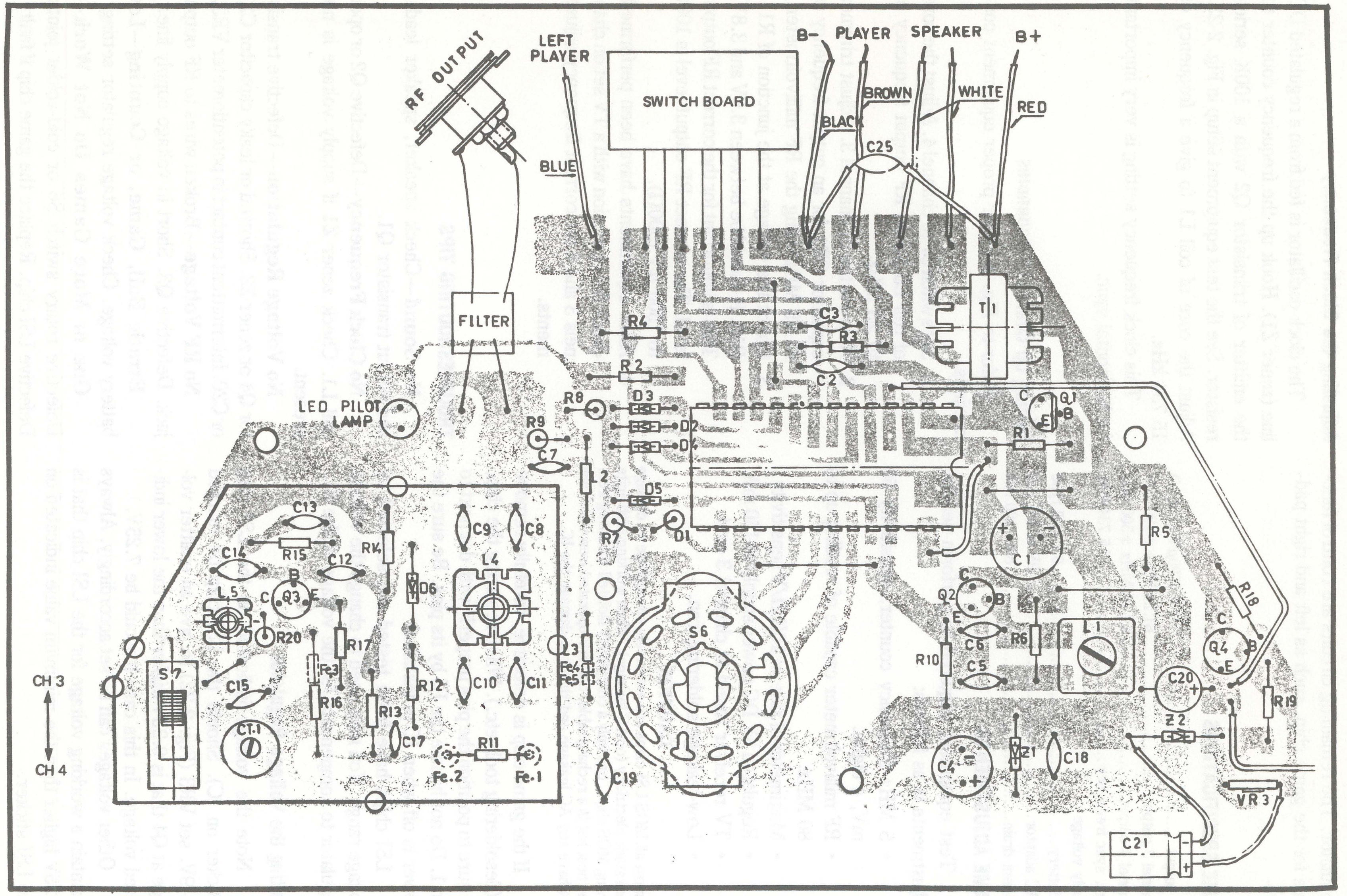



Fig. 2-22. PC board diagram of the 60-3052 video game.

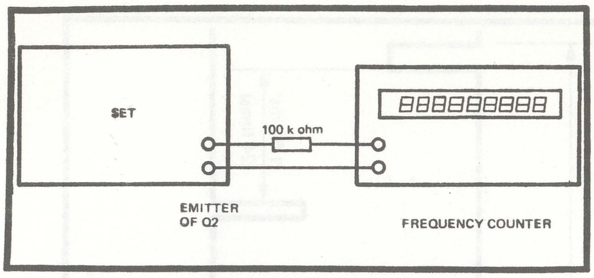



Fig. 2-23. Test setup for setting the clock frequency of the 60-3052.

## AY-3-8500-1 PIN CONNECTIONS & FUNCTIONS

- Pin 1. Not used. Do not use as a tie point.
- Pin 2. Ground. Negative power supply. Connect to chassis ground.
- Pin 3. Sound output found on this pin. A hit is a 976 Hz tone. A boundary reflection is a 488 Hz tone. A score is a 1950 Hz tone.
- Pin 4. Vcc. Positive power supply voltage.
- Pin 5. 2/4 angles input. An open circuit allows two rebound angles. A grounded pin allows four rebound angles.
- Pin 6. Ball output. The video signal for ball or target is output on this pin.
- Pin 7. Ball speed input. When this input is left open circuit, low speed is selected. In this mode the ball takes 1.30 seconds to traverse the screen. When connected to ground (logic *zero*) the high-speed option is selected. The ball then takes 0.65 seconds to go across the screen.
- Pin 8. Manual serve. When this input is connected to ground (logic *zero*) the play is restarted automatically after each score. When left open circuit, play stops after each score. The game can then be restarted by connecting this input to ground momentarily.
- Pin 9. Right player output. The video signal representing the right-hand player is outputted on this pin.
- Pin 10. Left player output. The video signal representing the left-hand player is outputted on this pin.
- Pin 11. Right bat input. A capacitor and variable resistor connected to this input govern the vertical position of the right-hand player. Use a 10K resistor in series with pot.
- Pin 12. Left bat input. A capacitor and variable resistor connected to this input govern the vertical position of the left-hand player. Use a 10K resistor in series with pot.
- Pin 13. Bat size input. When this input is left open circuit, large bats/players are selected. When connected to ground (logic *zero*) small bats/players are selected.
- Pin 14. Not used. Do not use as a tie point.
- Pin 15. Not used. Do not use as a tie point.
- Pin 16. The TV horizontal and vertical sync signals are outputted on this pin. See Figs. 2-25 and 2-26 for these various pulses.
- Pin 17. Clock input. The 2 MHz master timing clock is inputted to this pin.
- Pin 18. Rifle 1. Not connected for this model.
- Pin 19. Rifle 2. Not connected for this model.
- Pin 20. Table tennis. This game is selected by grounding this pin, *logic zero*. All others (pins 21-23) are left open.
- Pin 21. Hockey. Activated in the same manner as pin 20. Pins 20, 22, and 23 left open.
- Pin 22. Squash. Activated in the same manner as pin 20. Pins 20, 21, and 23 left open.
- Pin 23. Practice. Activated in the same manner as pin 20. Pins 20, 21, and 22 left open.
- Pin 24. Score and field output. The wide signal for the score and playing field is outputted on this pin.

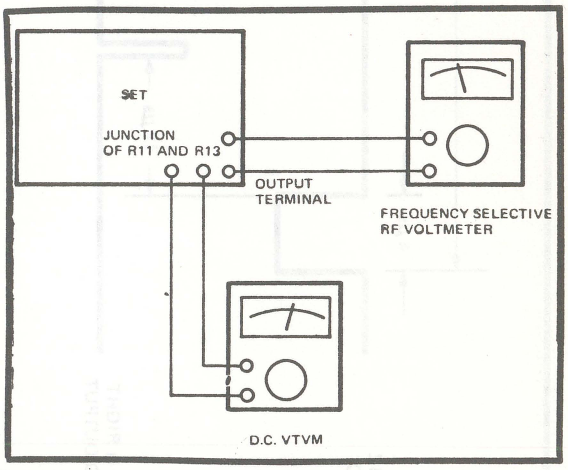



Fig. 2-24. Test setup for setting the channel frequencies of the 60-3052.

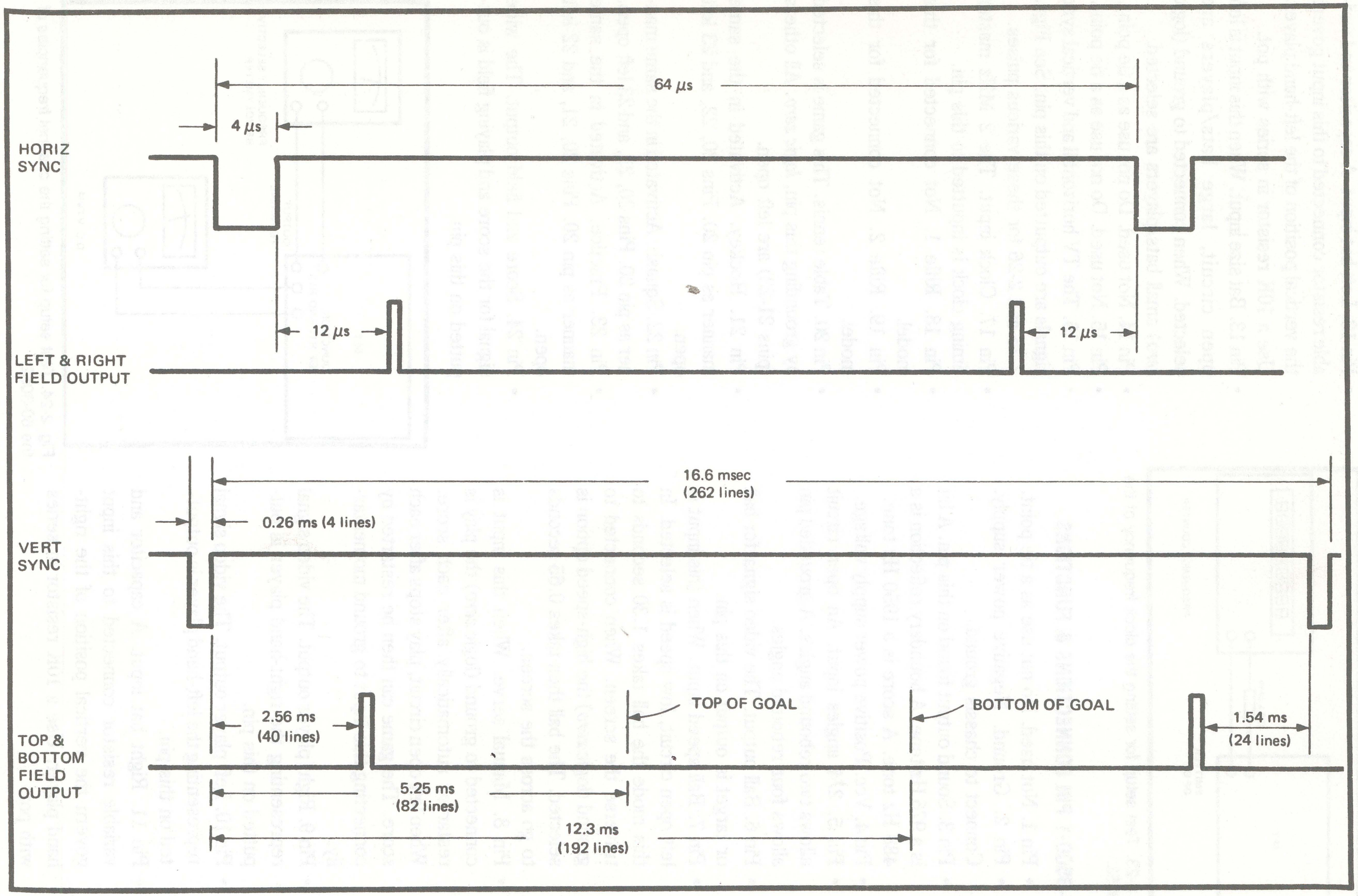



Fig. 2-25. Sync waveforms of the 60-3052.

- Pin 25. Reset input. This input is normally left open circuit. It is momentarily connected to ground (logic *zero*) to reset the score counters and to start a new game.
- Pin 26. Shot input. Not connected in this model.
- Pin 27. Hit input. Not used for this function in this model. Here it is connected to sound output pin 3 to insure sound termination when ball strikes the left-hand wall.
- Pin 28. Not used. Do not use as a tie point.

A representation of a typical video display is shown in Fig. 2-27, indicating the expected location and size of raster images. Along the top and left-hand borders of the display are two scales. The one along the top indicates the horizontal timing for the images. Horizontal timing is given in microseconds. Along the left-hand border is a scale indicating on which line or lines the images should appear. Notice in the right-hand portion of the figure is a table indicating the horizontal width of each image in microseconds and the vertical position in number of lines. For example, the bat should be 0.5 $\mu$s wide and appear on 28 lines (pin 13 open) or 14 lines (pin 13 grounded).

A schematic diagram for the 60-3052 is shown in Fig. 2-28. Both the game circuitry and RF mod-

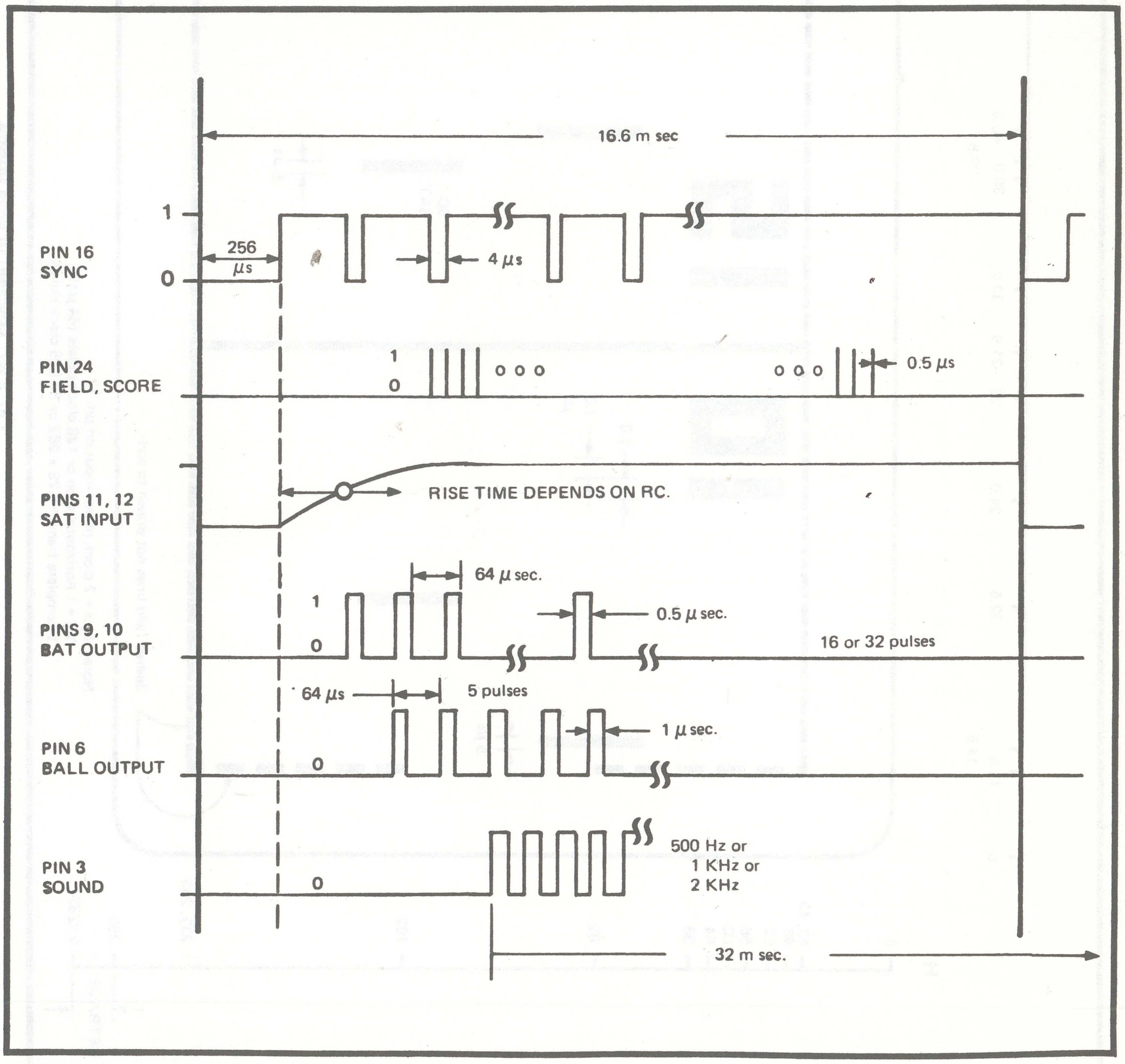
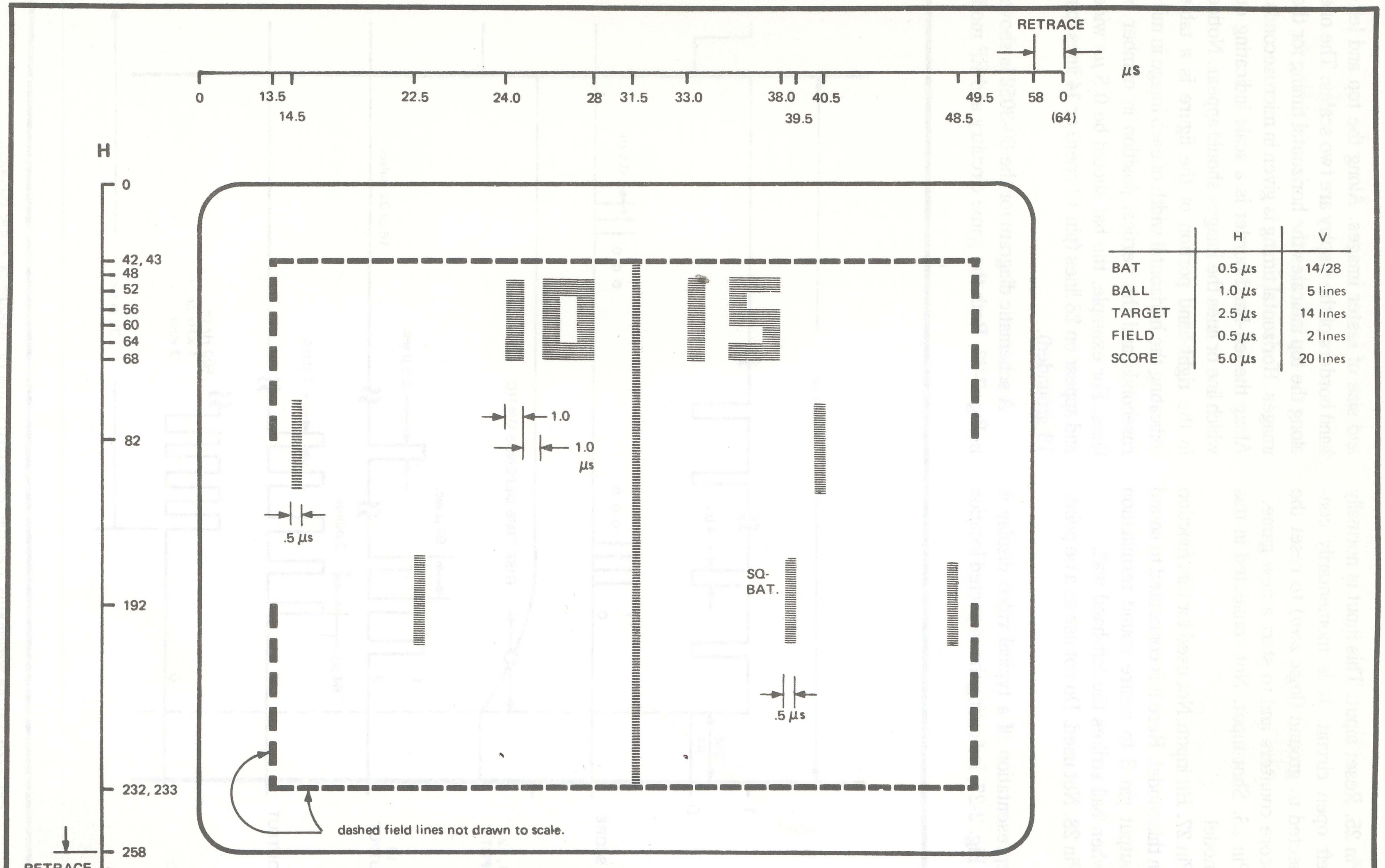



Fig. 2-26. Output waveforms from the game chip to the RF modulator in the 60-3052.




| | H | V |
|---|---|---|
| BAT | 0.5 μs | 14/28 |
| BALL | 1.0 μs | 5 lines |
| TARGET | 2.5 μs | 14 lines |
| FIELD | 0.5 μs | 2 lines |
| SCORE | 5.0 μs | 20 lines |

Notes: 1 μs = 2 clock pulses input on pin 17
1H = 1 horizontal scon or 128 clock pulses (64 μs)
1 complete frame = 128 x 262 or 33,536 clock pulses

**Fig. 2-27. Location of data pulses.**

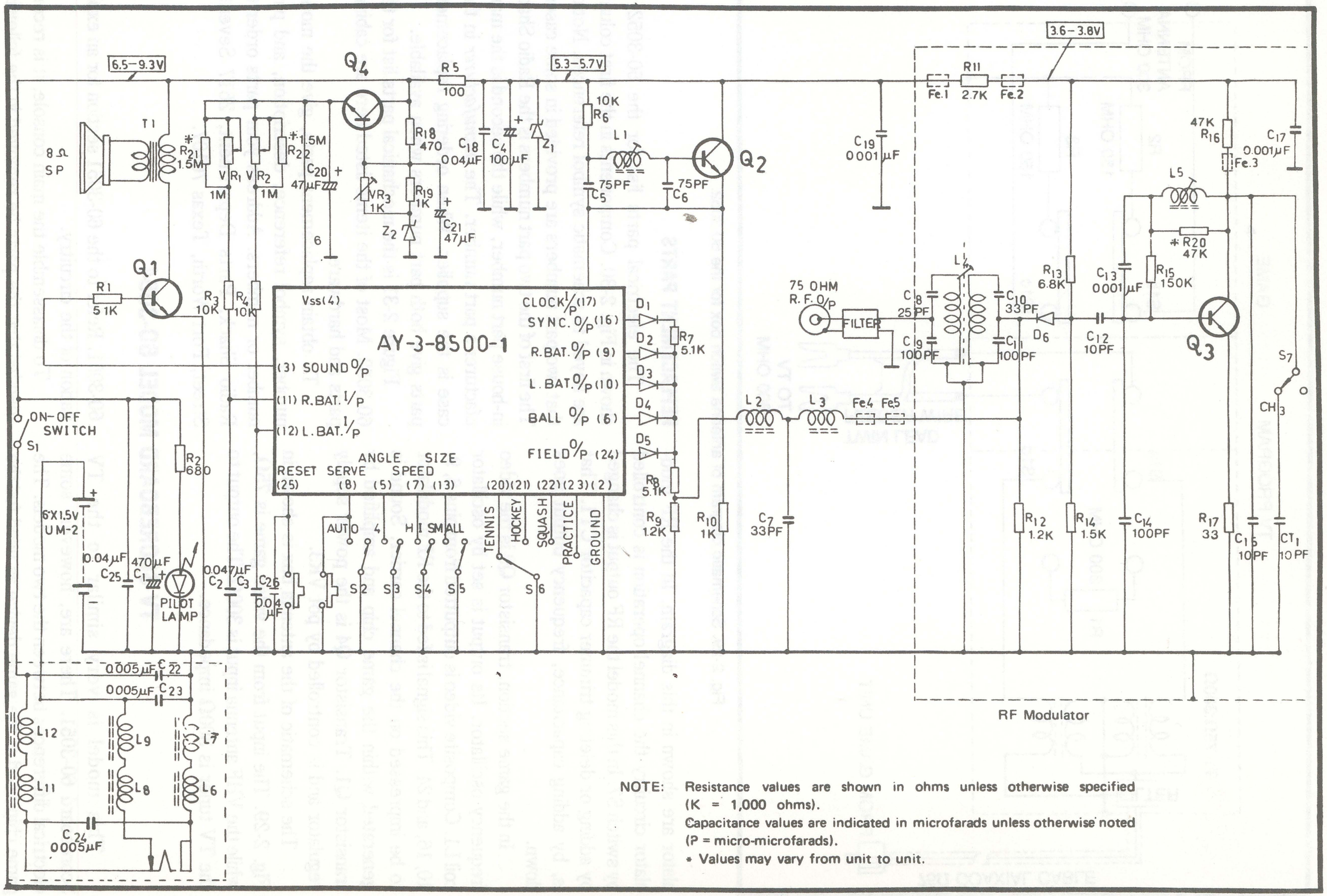



Fig. 2-28. Overall schematic diagram of the 60-3052 video game.

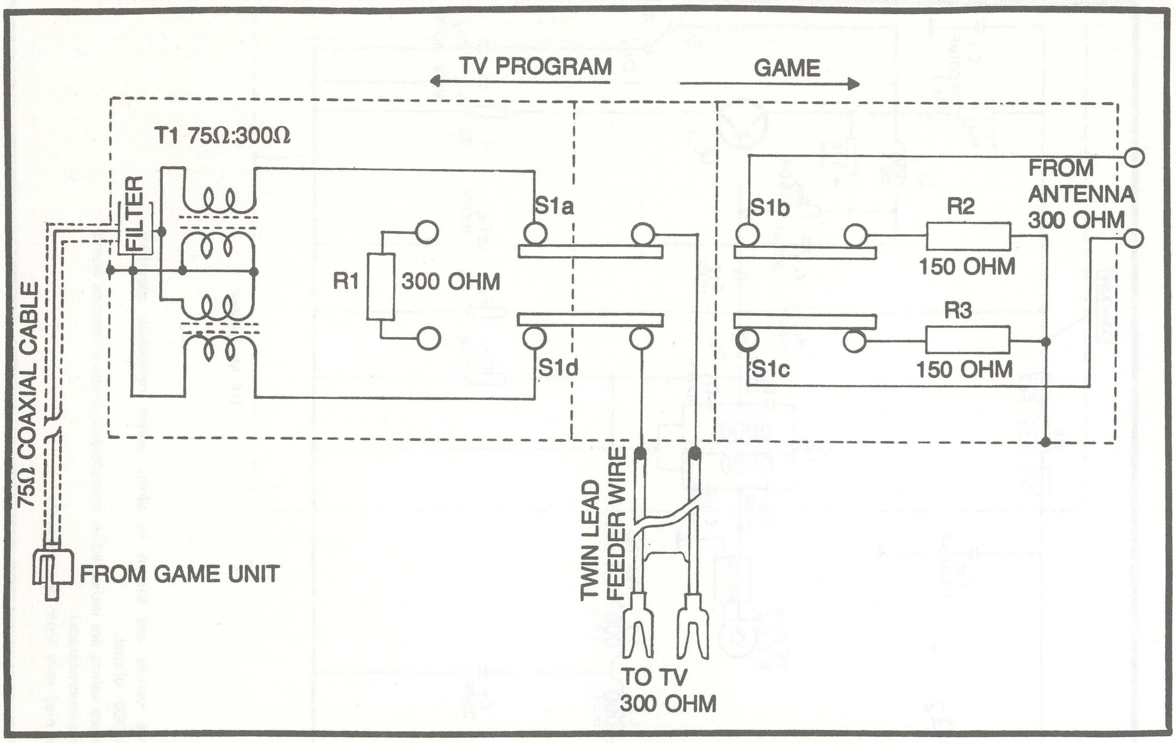



Fig. 2-29. Schematic diagram of antenna switch box for the 60-3052.

ulator are shown in this diagram. In the RF modulator circuitry the channel operation is controlled by switch S7. In this model the RF output is changed by adding or deleting trimmer capacitor CT1. That is, by adding capacitance, frequency output goes down.

In the game section, transistor Q2 is the video frequency oscillator. Its output is set by oscillator coil L1. Composite video is outputted from pins 6, 9, 10, 16, and 24. This signal is fed to the RF modulator to be impressed on the channel carrier. Sound is generated within the game chip and amplified by transistor Q1. Transistor Q4 is the power supply regulator and is controlled by pot VR3.

The schematic of the antenna box is shown in Fig. 2-29. The input from the video game is 75Ω, while the VHF antenna input is 300Ω. The output to the TV tuner is 300Ω impedance.

### REPLACEMENT PARTS

The electrical parts list for the 60-3052 is shown in Fig. 2-30. Components in the first column are keyed to schematic symbol references. Notice that two part numbers are provided in some cases. The first of the two part numbers is the Radio Shack in-house part number, while the second is the manufacturer's part number. The *manufacturer* in this case is the supplier. When ordering replacement parts give both part numbers when available.

Figure 2-31 is the mechanical parts list for the 60-3052. Most of the items listed here are cabinet parts and hardware.

To obtain replacement parts, give the model number, symbol reference, description, and part number or numbers. Address your parts order to Radio Shack, Parts Department, 2617 Seventh Street, Fort Worth, Texas 76107.

## TV SCOREBOARD MODEL 60-3054

This model is very similar to the TV Scoreboard 60-3051. There are, however, some electrical differences between the two models. The game chip used is the same device as used for the 60-3051. Refer to the 60-3051 section for an explanation of the circuitry.

To disassemble the main console, it is recommended that the parts be removed in the following

| Ref. No. | Description | RS No. | Mfr. No. |
|---|---|---|---|
| CAPACITORS | | | |
| C1 | Electrolytic cap. 470µF/10V | | 3E0171 |
| C2 | Mylar cap. 0.047µF/25V | | 3C1140 |
| C3 | Mylar cap. 0.047µF/25V | | 3C1140 |
| C4 | Electrolytic cap. 100µF/10V | | 3E0141 |
| C5 | Ceramic cap. 75PF | | 3C0322 |
| C6 | Ceramic cap. 75PF | | 3C0322 |
| C7 | Ceramic cap. 33PF | | 3C0211 |
| C8 | Ceramic cap. 25PF | | 3C0181 |
| C9 | Ceramic cap. 100PF | | 3C0362 |
| C10 | Ceramic cap. 33PF | | 3C0211 |
| C11 | Ceramic cap. 100PF | | 3C0362 |
| C12 | Ceramic cap. 10PF | | 3C0111 |
| C13 | Ceramic cap. 0.001µF | | 3C0583 |
| C14 | Ceramic cap. 100PF | | 3C0362 |
| C15 | Ceramic cap. 10PF | | 3C0111 |
| C16 | Not used | | |
| C17 | Ceramic cap. 0.001µF | | 3C0583 |
| C18 | Ceramic cap. 0.04µF | | 3C0664 |
| C19 | Ceramic cap. 0.001µF | | 3C0583 |
| C20 | Electrolytic cap. 47µF/10V | | 3E0131 |
| C21 | Electrolytic cap. 47µF/10V | | 3E0131 |
| C22 | Ceramic cap. 0.005µF | | 3C0624 |
| C23 | Ceramic cap. 0.005µF | | 3C0624 |
| C24 | Ceramic cap. 0.005µF | | 3C0624 |
| C25 | Ceramic cap. 0.04µF | | 3C0664 |
| C26 | Ceramic cap. 0.04µF | | 3C0664 |
| CT1 | Trimmer 10PF | C-0767 | 3E1010 |
| DIODE | | | |
| D1 | 1N4148 | | 3M105 |
| D2 | 1N4148 | | 3M105 |
| D3 | 1N4148 | | 3M105 |
| D4 | 1N4148 | | 3M105 |
| D5 | 1N4148 | | 3M105 |
| D6 | 1N4148 | | 3M105 |
| FERRITE BEAD | | | |
| Fe1 | 3 x 3.5MM | | 2B0510 |
| Fe2 | 3 x 3.5MM | | 2B0510 |
| Fe3 | 5 x 3.5MM | | 2B0520 |
| Fe4 | 5 x 3.5MM | | 2B0520 |
| Fe5 | 5 x 3.5MM | | 2B0520 |
| COILS | | | |
| L1 | OSC coil 95µH | CA-4817 | 2T0660 |
| L2 | RF choke 90µH | CB-2331 | 2G1520 |
| L3 | RF choke 90µH | CB-2331 | 2G1520 |
| L4 | Double tuned coil | | 2T0680 |
| L5 | RF OSC coil 0.43µH | | 2T0670 |
| L6 | RF choke 100µH 300mA | | 2G1510 |
| L7 | RF choke 100µH 300mA | | 2G1510 |
| L8 | RF choke 100µH 300mA | | 2G1510 |
| L9 | RF choke 100µH 300mA | | 2G1510 |
| L10 | RF choke assembly | | 1T0020 |
| L11 | RF choke 100µH 300mA | | 2G1510 |
| L12 | RF choke 100µH 300mA | | 2G1510 |
| TRANSISTOR | | | |
| Q1 | ED1702/PE8050B | | 3M0331 |
| Q2 | ED1502A | | 3M0011 |
| Q3 | ED1502B | | 3M0012 |
| Q4 | 2SD72 | | 3M086 |
| RESISTOR | | | |
| R1 | Carbon film resistor ¼W 5.1k ohm | NEE-0252 | 3R0661 |
| R2 | Carbon film resistor ¼W 680 ohm | NEE-0183 | 3R0481 |
| R3 | Carbon film resistor ¼W 10k ohm | NEE-0281 | 3R0711 |
| R4 | Carbon film resistor ¼W10k ohm | NEE-0281 | 3R0711 |
| R5 | Carbon film resistor ¼W 100 ohm | NEE-0132 | 3R0321 |
| R6 | Carbon film resistor ¼W 10k ohm | NEE-0281 | 3R0711 |
| R7 | Carbon film resistor ¼W 5.1k ohm | NEE-0252 | 3R0661 |
| R8 | Carbon film resistor ¼W 5.1k ohm | NNE-0252 | 3R0661 |
| R9 | Carbon film resistor ¼W 1.2k ohm | NEE-0199 | 3R0521 |
| R10 | Carbon film resistor ¼W 1k ohm | NEE-0196 | 3R0511 |
| R11 | Carbon film resistor ¼W 2.7k ohm | NEE-0224 | 3R0581 |
| R12 | Carbon film resistor ¼W 1.2k ohm | NEE-0199 | 3R0521 |
| R13 | Carbon film resistor ¼W 6.8k ohm | | 3R0681 |
| R14 | Carbon film resistor ¼W 1.5k ohm | NEE-0206 | 3R0531 |
| R15 | Carbon film resistor ¼W 150k ohm | NEE-0384 | 3R0971 |
| R16 | Carbon film resistor ¼W 47k ohm | NEE-0340 | 3R0861 |
| R17 | Carbon film resistor ¼W 33 ohm | NEE-0087 | 3R0221 |
| R18 | Carbon film resistor ¼W 470 ohm | NEE-0169 | 3R0431 |
| R19 | Carbon film resistor ¼W 1k ohm | NEE-0196 | 3R0511 |
| R20 | Carbon film resistor ¼W 47k ohm | NEE-0340 | 3R0861 |
| R21 | Carbon film resistor ¼W 1.5M ohm | NEE-0450 | 3R1161 |
| R22 | Carbon film resistor ¼W .5M ohm | NEE-0450 | 3R1161 |
| OTHER ELECTRICAL PARTS | | | |
| S1-S5 | Switch P.C. board | X-7368 | 1P1362 |
| S6 | Rotary Switch 3P4T | S-1266 | 2S0820 |
| S7 | Slide switch 1P2T | S-2372 | 2S0040 |
| T1 | Output transformer | TD-0152 | 2T1380 |
| VR1 | Variable resistor (slide) 1M ohm | P-0794 | 2R0221 |
| VR2 | Variable resistor (slide) 1M ohm | P-0794 | 2R0221 |
| VR3 | Variable resistor 1/8W 1M ohm | P-0793 | 3R2041 |
| Z1 | Zener diode 5.5V 1mA ½W | | 3M1221 |
| Z2 | Zener diode 6.5V 1mA ½W | | 3M1431 |
| | DC filter P.C. board | | 1P2631 |
| | Earphone jack 2.5mm | J-0818 | 3J0210 |
| | IC socket | J-6478 | 2J0010 |
| | L.S.I. AY-3-8500-1 | | 1V0590 |
| | L.E.D. pilot lamp | L-0761 | 1V1080 |
| | Main P.C. board | | 1P2522 |
| | Phono socket | J-6477 | 2J0021 |
| | Speaker 8 ohm 2¼" | S-4681 | 2L0021 |
| PARTS FOR ANTENNA BOX | | | |
| R1 | Carbon film resistor ¼W 300 ohm | NEE-0158 | 3R0401 |
| R2 | Carbon film resistor ¼W 150 ohm | NEE-0142 | 3R0341 |
| R3 | Carbon film resistor ¼W 150 ohm | NEE-0142 | 3R0341 |
| T1 | 75 : 300 ohm balun transformer | | 2G1530 |
| | RF choke coil (filter) | | 1T0020 |
| | Coaxial cable with plug ASM | W2129 | 38P664 |
| | Twin lead feeder with connector ASM | W2128 | 3W1389 |

**Fig. 2-30. Electrical parts list for the 60-3052 video game.**

| Ref. No | Description | RS No. | Mfr. No |
|---|---|---|---|
| | Antenna box assembly | X-7391 | 38P634 |
| | Back cabinet | Z-3402 | 4A0890 |
| | Back lable | | 7J114 |
| | Battery door | DG-0186 | 4A0870 |
| | Battery positive plate | | 4T0800 |
| | Battery negative spring | RB-5755 | 4T0790 |
| | Battery connecting terminal | B-0273 | 4T0780 |
| | Battery sponge | | 6G0330 |
| | Brass insert | | 41B-149-10 |
| | Brass insert | | 41B 149 23 |
| | Control panel | Z 3403 | 7A026 |
| | Connecting terminal | J-4489 | 4T0820 |
| | Disc | | 4J0010 |
| | Disc retainer mylar | | 4K0850 |
| | Ext teeth washer | | 31P140 |
| | Eyelet | | 6W0290 |
| | Front cabinet | Z-3401 | 4A0882 |
| | Insulator | | 4F 0230 |
| | Jack cap | | 4B0070 |
| | Lamp glass | HB 5849 | 4A0850 |
| | Mounting bracket right | | 4A0080 |
| | Mounting bracket left | | 4B0160 |
| | Mylar washer | | 6W0250 |
| | Mylar cover | | 4K0860 |
| | Name plate | HB 5851 | |
| | Press pin | | 4T0840 |
| | Reset knob | K 2508 | 4A0840 |
| | Selecting knob | K 2506 | 4A0820 |
| | Slide control knob | K 2507 | 4A0830 |
| | Slide control flet | | 4I 0220 |
| | Shield can | | 4T0770 |
| | Shield can cover | | 4T0762 |
| | Shield plate | | 4T0750 |
| | Soldering terminal | | 31P139 |
| | Speaker screen | | 4F0210 |
| | Switch contact | | 4T0811 |
| | Switch knob | K-2509 | 4A0810 |
| | Screw T2.6 CR-P/H | | 6S1541 |
| | Screw ST2.6 x 8 CR-P/H | | 6S1551 |
| | Screw ST2.6 x 6 CR-R/H | | 6S0040 |
| | Screw M3 x 0.6P x 10 CR-P/H | | 6S1460 |
| | Screw M3 x 0.5 x 5 CR-R/H | | 6S1370 |
| | Screw MT3 x 8 CR-R/H | | 6S0080 |
| | Screw ST3 x 7 CR-R/H | | 6S1430 |
| PARTS FOR ANTENNA BOX | | | |
| | Adhesive pad | | 30P582 |
| | Bare wire awg#22 55mm | | 3W1302 |
| | Body, antenna box | Z-3400 | 51P109 |
| | Coaxial cable with plug ASM | W-2129 | 38P664 |
| | Cover, antenna box | Z-3404 | 38P612 |
| | Label | HB-5872 | 30P812-5 |
| | Rivet | | 30P1040 |
| | Rivet | | 30P1041 |
| | Shield, antenna box | | 30P992 |
| | Slide switch | S-2373 | 38P633 |
| | Screw | | |
| | Strain relief bushing | | |
| | Strain relief bushing | | |

Fig. 2-31. Mechanical parts list for the 60-3052 video game.

order: (1) battery door, (2) battery holder, (3) main owner case, (4) game select knob, (5) main PC board, and (6) main upper case.

To disassemble the left-hand control, remove the screw, lower portion of the hand control, lower hand control, paddle control knob, 1M pot, and upper portion of the hand control.

To disassemble the right-hand control, remove the screw, lower portion of the hand control, paddle control knob, 1M pot, knurled nut, lockwasher, SPST pushbutton switch, and upper portion of the hand control.

## CIRCUIT DIFFERENCES

The following paragraphs explain the major differences between the 60-3054 and its predecessor, the 60-3051. The schematic diagram of the 60-3054 is shown in Fig. 2-32.

### Game IC

The 60-3054 uses the same device as the 60-3051.

### Power Supply

A zener diode, CR1, is used without the help of a series-pass transistor. Current limiting for the diode is through the use of L4, a 620 $\mu$H coil, with a resistance of 27Ω. Under AC adapter power, another 620 $\mu$H coil, L5, is used to give an additional 27Ω resistance to the zener diode current.

### Audio Circuit

The same audio amplifier is used, except that peak currents are limited by resistor R1. Resistor R1 and capacitor C2 form a separate power supply of sorts to give the same audio volume.

### Video Mixing

The 60-3054 game uses a passive video mixer instead of an active NOR gate mixer. Resistors R6, R7, R8, R9, and R10 mix video and sync signals before being applied to the modulator. The video is applied to the modulator in true (sync down) form.

### Modulator

A different modulator is used on the 60-3054 than was used on the 60-3051. It will accept true video (sync down) and its internal structure is different. It has Vcc power applied to it all the time and the channel select terminal is brought to ground (GND) for channel 4 and Vcc for channel 3.

### Option Switches

There are no electrical differences although there are mechanical differences in the front-panel switches.

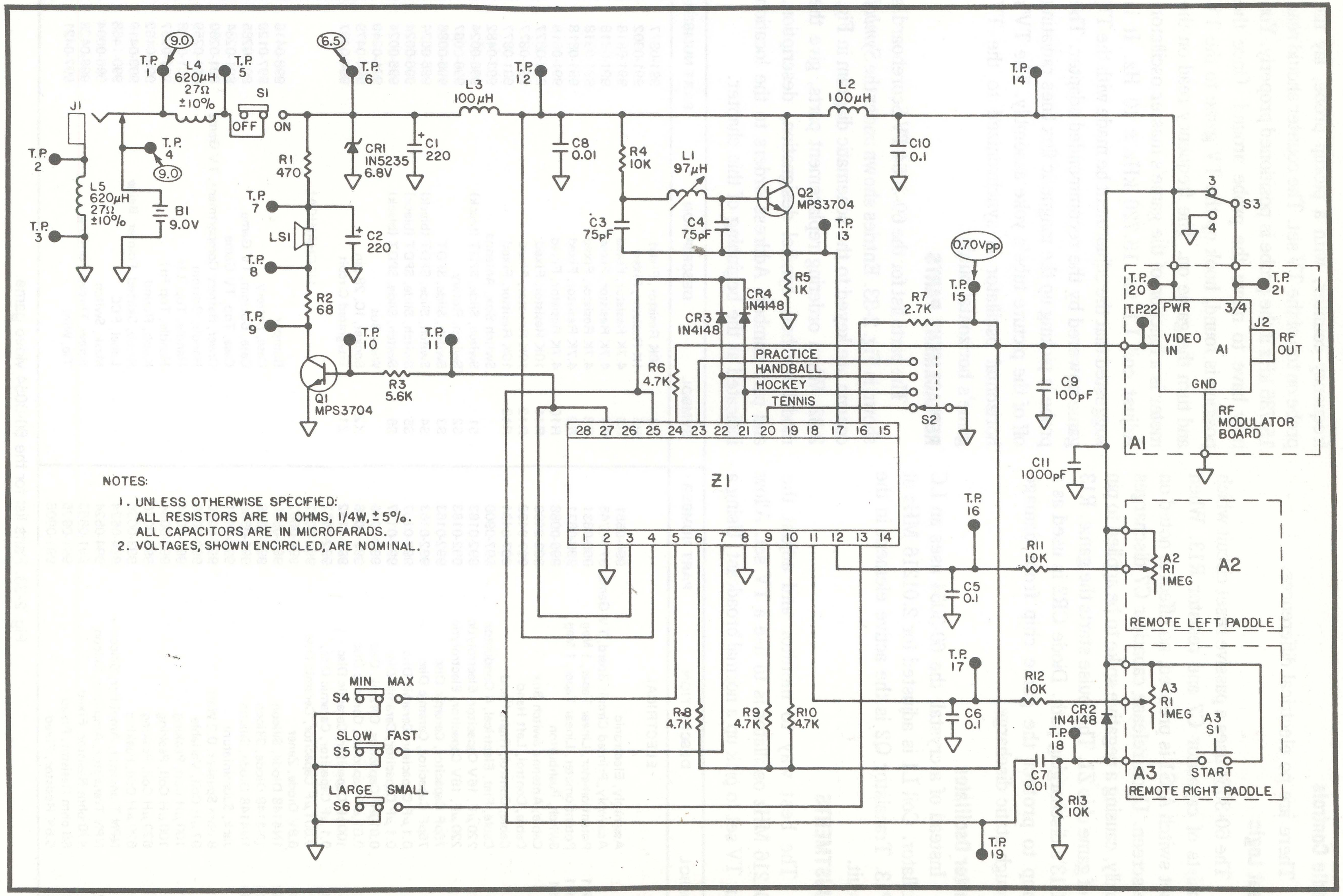



Fig. 2-32. Schematic diagram of the 60-3054 video game.

## Paddle Controls

There are no electrical differences.

## Reset Logic

The 60-3054 uses a passive reset circuit which consists of capacitor C7 and resistor R13. When reset switch A3S1 is pressed, no effect is noted on the screen. Upon release capacitor C7 discharges rapidly, causing a negative spike to be applied to pin 25 of game chip Z1. This pulse starts the game. R13 is C13's discharging path. Diode CR2 is used as a clamp to protect the game chip from damage through static discharge.

## Master Oscillator

Instead of a crystal, the 60-3054 uses an LC oscillator. Coil L1 is adjusted for 2.01216 MHz at TP13. Transistor Q2 is the active element in the circuit.

## ADJUSTMENTS

The best way to monitor and adjust the 2.01216 MHz oscillator is to use a TV set. Allow your TV set to pick up a normal broadcast. Using a frequency counter, with a pickup probe, lay the probe on top of the TV set. The counter should read 15.735 kHz if the probe is positioned properly. You may have to move the probe around. Once the position is found, hook up the TV game to the TV and turn the game on. The frequency read on the meter is a function of the game's master oscillator. Adjust coil L1 for 15.720 kHz ± 10 Hz. It is suggested that the adjustment be made with the TV game powered by the recommended adapter. The probe is picking up the magnetic flux lines radiating off of the picture tube's yoke assembly. The TV's horizontal oscillator is synchronized to the TV game's horizontal output.

## REPLACEMENT PARTS

The parts list for the 60-3054 TV Scoreboard is shown in Fig. 2-33. Entries shown under the *Symbol* column are keyed to the schematic diagram in Fig. 2-32. When ordering replacement parts, give the model number, symbol designation, description, and part number. Address orders to the location indicated at the beginning of this chapter.

| SYMBOL | DESCRIPTION | PART NUMBER |
|---|---|---|
| | ELECTRICAL | |
| A1 | Assembly, Electronic | 994-0551 |
| | Assembly, Printed Circuit Board, TV Game | 871-0745 |
| A2R1 | Potentiometer, Linear Taper, 1 Meg | 996-0631 |
| A3R1 | Potentiometer, Linear Taper, 1 Meg | 996-0631 |
| A3S1 | Switch, Pushbutton | 996-0088 |
| | Cable, Antenna Switch Box | 993-0430 |
| | Cable, Control, Left Hand | 997-0432 |
| | Cable, Control, Right Hand | 997-0434 |
| | Cable, Flat, Electrical, 4 Conductor | 997-0900 |
| C1 | 220 $\mu$F, 16V Capacitor, Electrolytic | 992-0183 |
| C2 | 220 $\mu$F, 16V Capacitor, Electrolytic | 992-0183 |
| C3 | 75pF Capacitor, Ceramic Disc | 992-0163 |
| C4 | 75pF Capacitor, Ceramic Disc | 992-0163 |
| C5 | 0.1 $\mu$F Capacitor, Ceramic Disc | 992-0157 |
| C6 | 0.1 $\mu$F Capacitor, Ceramic Disc | 992-0157 |
| C7 | 0.01 $\mu$F Capacitor, Ceramic Disc | 992-0046 |
| C8 | 0.01 $\mu$F Capacitor, Ceramic Disc | 992-0046 |
| C9 | 100pF Capacitor, Ceramic Disc | 992-0182 |
| C10 | 0.1 $\mu$F Capacitor, Ceramic Disc, | 992-0157 |
| C11 | 0.001 $\mu$F Capacitor, Ceramic Disc | 992-0022 |
| CR1 | 6.8V Diode, Zener | 994-0602 |
| CR2 | 1N4148 Diode, Silicon | 994-0588 |
| CR3 | 1N4148 Diode, Silicon | 994-0588 |
| CR4 | 1N4148 Diode, Silicon | 994-0588 |
| J1 | Jack, Subminiature | 997-0461 |
| LS1 | 8 ohm Speaker, 0.2 Watt | 995-0070 |
| L1 | 97 $\mu$H Coil, Variable | 993-0035 |
| L2 | 100 $\mu$H Coil, Peaking | 993-0034 |
| L3 | 100 $\mu$H Coil, Peaking | 993-0034 |
| L4 | 620 $\mu$H Coil, Peaking | 993-0036 |
| L5 | 620 $\mu$H Coil, Peaking | 993-0036 |
| Q1 | NPN Transistor, Amplifier, Silicon | 994-0524 |
| Q2 | NPN Transistor, Amplifier, Silicon | 994-0524 |
| R1 | 470 ohm Resistor, Fixed | 991-0883 |
| R2 | 68 ohm Resistor, Fixed | 991-0905 |
| R3 | 5.6K Resistor, Fixed | 991-0906 |
| R4 | 10K Resistor, Fixed | 991-0877 |
| R5 | 1K Resistor, Fixed | 991-0902 |
| R6 | 4.7K Resistor, Fixed | 991-0818 |
| R7 | 4.7K Resistor, Fixed | 991-0818 |
| R8 | 4.7K Resistor, Fixed | 991-0818 |
| R9 | 4.7K Resistor, Fixed | 991-0818 |
| R10 | 4.7K Resistor, Fixed | 991-0818 |
| R11 | 10K Resistor, Fixed | 991-0877 |
| R12 | 10K Resistor, Fixed | 991-0877 |
| R13 | 10K Resistor, Fixed | 991-0877 |
| | Switch Box, Antenna | 993-0482 |
| S1 | Switch, Slide, SPDT (black) | 996-0024 |
| S2 | Switch, Rotary | 996-0087 |
| S3 | Switch, Slide, SPDT | 996-0086 |
| S4 | Switch, Slide, SPDT (black) | 996-0024 |
| S5 | Switch, Slide, SPDT (black) | 996-0024 |
| S6 | Switch, Slide, SPDT (black) | 996-0024 |
| | Wire, Bus | 991-0240 |
| XZ1 | Socket, IC, 28 pin | 994-0479 |
| Z1 | Integrated Circuit | 994-0487 |
| | MECHANICAL | |
| | Bumper | 998-0416 |
| | Case, Battery | 997-0129 |
| | Case, Bottom, TV Game | 801-0285 |
| | Case, Top, TV Game | 801-0284 |
| | Cover, Battery Compartment, TV Game | 801-0260 |
| | Handle, Bottom | 801-0259 |
| | Handle, Top, LH | 801-0258 |
| | Handle, Top RH | 801-0257 |
| | Knob, Round | 998-0452 |
| | Knob, Skirted, Pointer, Beige | 998-0419 |
| | Label, FCC | 990-1468 |
| | Mask, Switch | 996-0094 |
| | Screw, Thread Forming | 998-0428 |
| | Tie, Wire | 997-0421 |

Fig. 2-33. Parts list for the 60-3054 video game.

# TV SCOREBOARD MODEL 60-3055

Unlike the previous two Radio Shack games using the GI game chip, the 60-3055 game turns to the MM57100N game chip by National Semiconductor. Along with game chip MM57100N, the 60-3055 employs a color generator/RF modulator chip, LM1889. Hence the Radio Shack video game now moves to a color display.

The 60-3055 is made in three versions: American/Canadian, Australian, and European. All three versions are identical with the exception of the operating frequencies. Figure 2-34 is the block diagram for models used in the America/Canada, while Fig. 2-35 is the block diagram for models sold in Australia and Europe.

## SPECIFICATIONS

RF output

- USA and Canada ...................... 600–5000 $\mu$V at 300Ω
- Australia.................................. 0.6–mV at 75Ω
- Europe.................................. 0.6–3.0 mV at 75Ω

Output frequencies

CH 3 for USA and Canada:

- Visual ........................................ 61.25 MHz
- Aural ........................................ 65.75 MHz

Ch 4 for USA and Canada:

- Visual ........................................ 67.25 MHz
- Aural ........................................ 71.75 MHz

CH 0 for Australia:

- Visual ........................................ 46.25 MHz
- Aural ........................................ 51.75 MHz

CH 4 for Europe:

- Visual ........................................ 62.25 MHz
- Aural ........................................ 67.25 MHz

Horizontal frequency:

- USA and Canada ........................................ 15.734 kHz
- Australia........................................ 15.625 kHz
- Europe ........................................ 15.625 kHz

Color carrier:

- USA and Canada ........................................ 3.579545 MHz
- Australia ........................................ 4.433618 MHz
- Europe ........................................ 4.433618 MHz

Ball-to-paddle hit AF ........................................ 491 Hz

Scan line frequency:

- USA and Canada ........................................ 525
- Australia and Europe ........................................ 625

Voltage supply:

- USA and Canada ........................................ 120V 60 Hz AC
- Australia ........................................ 240V 50 Hz AC
- Europe ........................................ 220V 50 Hz AC

Current drain:

- USA and Canada ........................................ 120 mA
- Austrailia and Europe ........................................ 125 mA

## SYMPTOM/CAUSE INFORMATION

Listed below are several typical symptoms that can be exhibited by the 60-3055. Each of these is displayed in boldface type. Directly below each symptom are probable causes of such symptoms. To use this information to its best advantage, skim through the list of symptoms to locate the one that fits the trouble at hand. If the exact one is not shown, select one that comes close to the malfunction. Then one by one, check the indicated probable causes for possible defects. To aid troublshooting, diagrams of IC1 through IC4 are shown in Figs. 2-36, 2-37, 2-38, and 2-39.

### No Output

- Check power supply for 9V and 15V outputs.
- Check the outputs of the game IC with an oscilloscope. See Figs. 2-40 and 2-41 for expected waveforms.
- Check PC board for poor soldering connections and cables for breaks.

### No Color

- Check the setting of trimmer capacitor C14.
- Check channel alignment.

### No Sound

- Check the setting of coil L3.
- Check TV receiver volume setting.

### Paddles Vibrate

- Too much ripple in power supply.
- Defective capacitor C1, regulator IC1, or transistor Q1.

### Erratic Ball or Game

- Defective MM57100N chip.

### No Discernable Picture

- Check channel alignment.
- Check the following ICs in this sequence: MM53104N, LM1889N, and MM57100N.

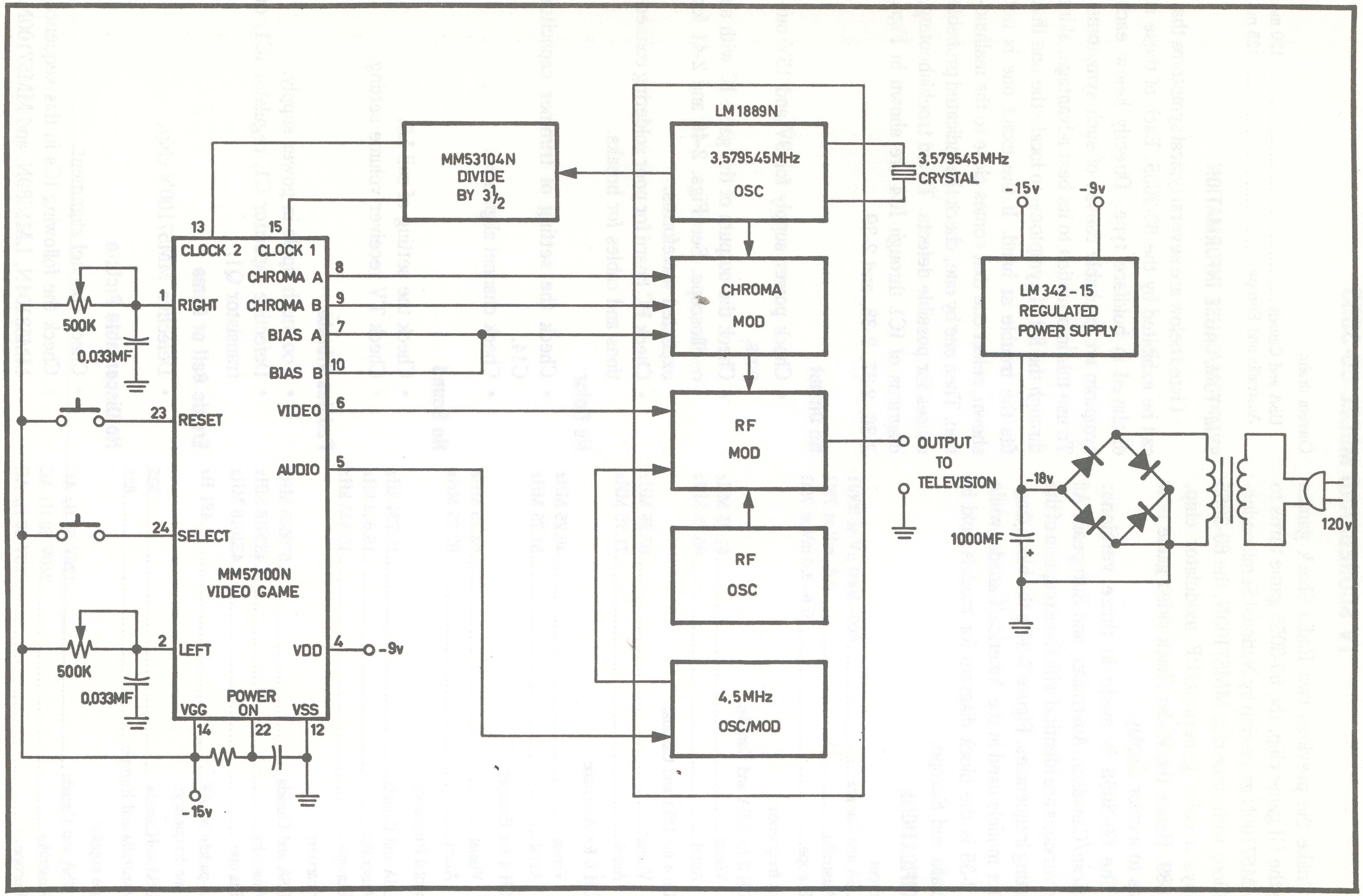



Fig. 2-34. Block diagram of models of the 60-3055 sold in the USA and Canada using 525-line scan.

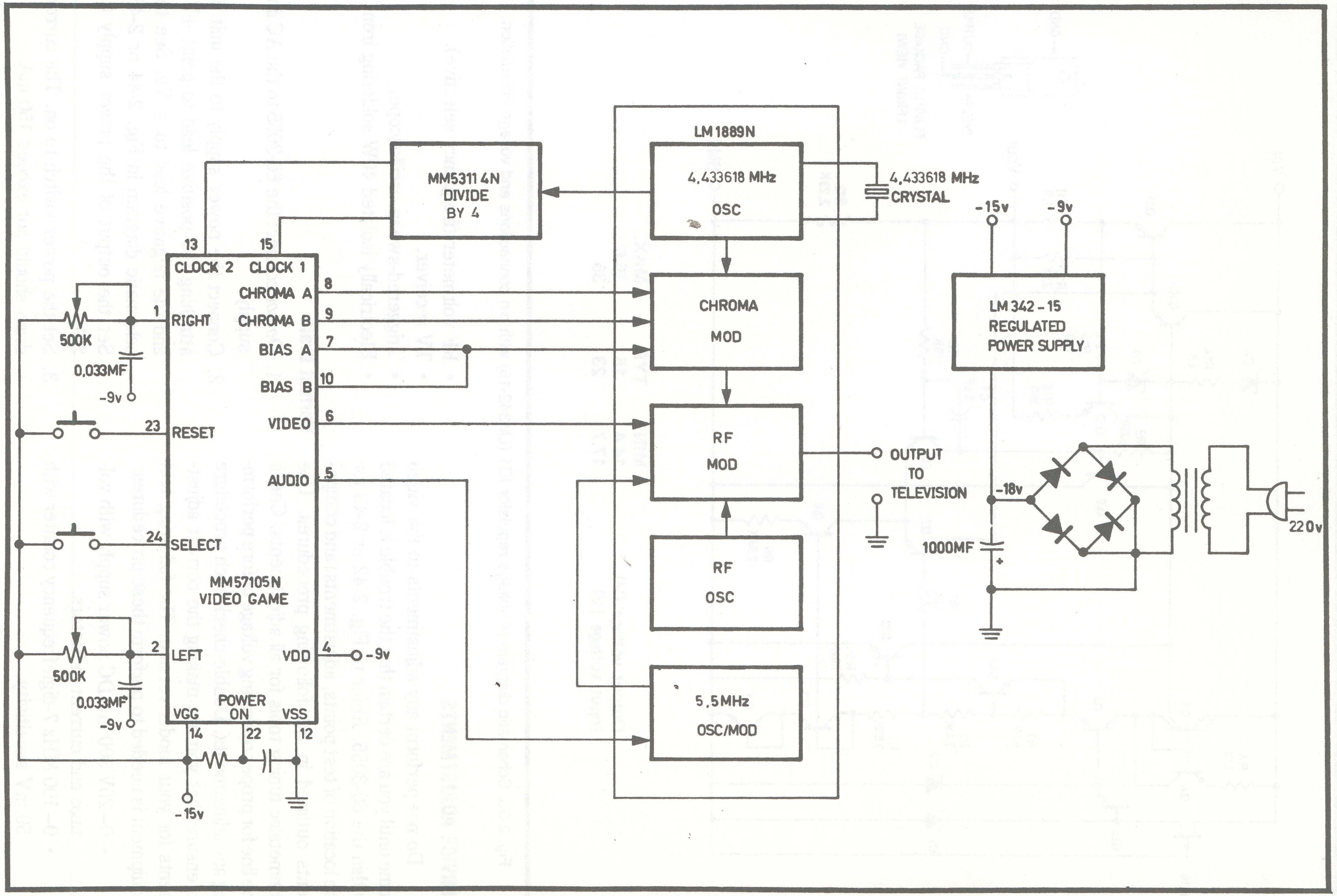
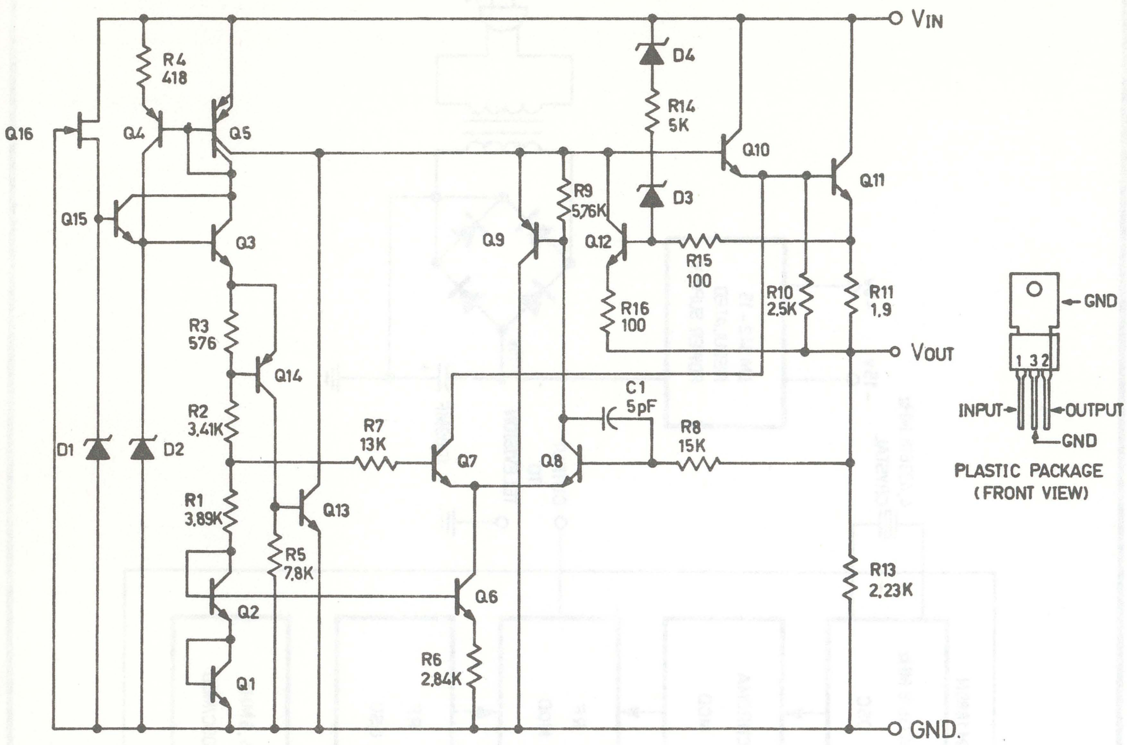



Fig. 2-35. Block diagram of models sold in Australia and Europe using 625-line scan.




| | MIN. | TYP. | MAX. |
|---|---|---|---|
| Output voltage (V) | 14.4 | 15 | 15.6 |
| Input voltage (V) | 17.7 | 23 | 35 |

Fig. 2-36. Schematic diagram of voltage regulator IC1 (LM342-15) with pin connections and voltage information.

## SERVICE ADJUSTMENTS

Do not perform any adjustments to the video game until you are certain that the trouble is located within the 60-3055. Refer to Fig. 2-42 or 2-43 for the location of test points, adjustments, and components outlined in the following procedures. Use nonmetallic tuning tools for all adjustments. Check the line for proper operating voltage before performing any adjustments. Double-check each procedure to ensure that you are making the correct adjustments for your model version. The following test equipment is needed to perform these procedures:

- 0–20V 300 mA DC power supply with voltage and current indicators.
- 0–100 MHz 7-digit frequency counter with 50 mV sensitivity.
- RF voltmeter (frequency selective).
- TV receiver.
- Triggered-sweep oscilloscope.
- Electrically isolated 40W soldering iron.

### Current Drain

1. *Do not* connect the 60-3055 to the AC line supply.
2. Connect the power supply to the unit by attaching the positive lead to point +Ve and the negative lead to – Ve. See the schematic diagram in Fig. 2-44 or 2-45. Set the output of the power supply for 20V.
3. Set the power switch to on. The current drain should not exceed 150 mA.

### Channel Frequencies

Maintain the same power supply connections as outlined under *Current Drain.* Select one of the following procedures.

*USA/Canadian models:*

1. Set switch SW2 for channel 4.
2. Connect the frequency counter across the antenna terminals.
3. Adjust coil L1 for an output frequency of 67.25 MHz ±20 kHz.
4. Set switch SW2 to channel 3.
5. Adjust coil L2 for an output frequency of 61.25 MHz ±20 kHz.
6. Set the frequency counter aside. Connect the 60-3055 to an operating TV receiver.
7. Check the operation on channel 3 and 4.

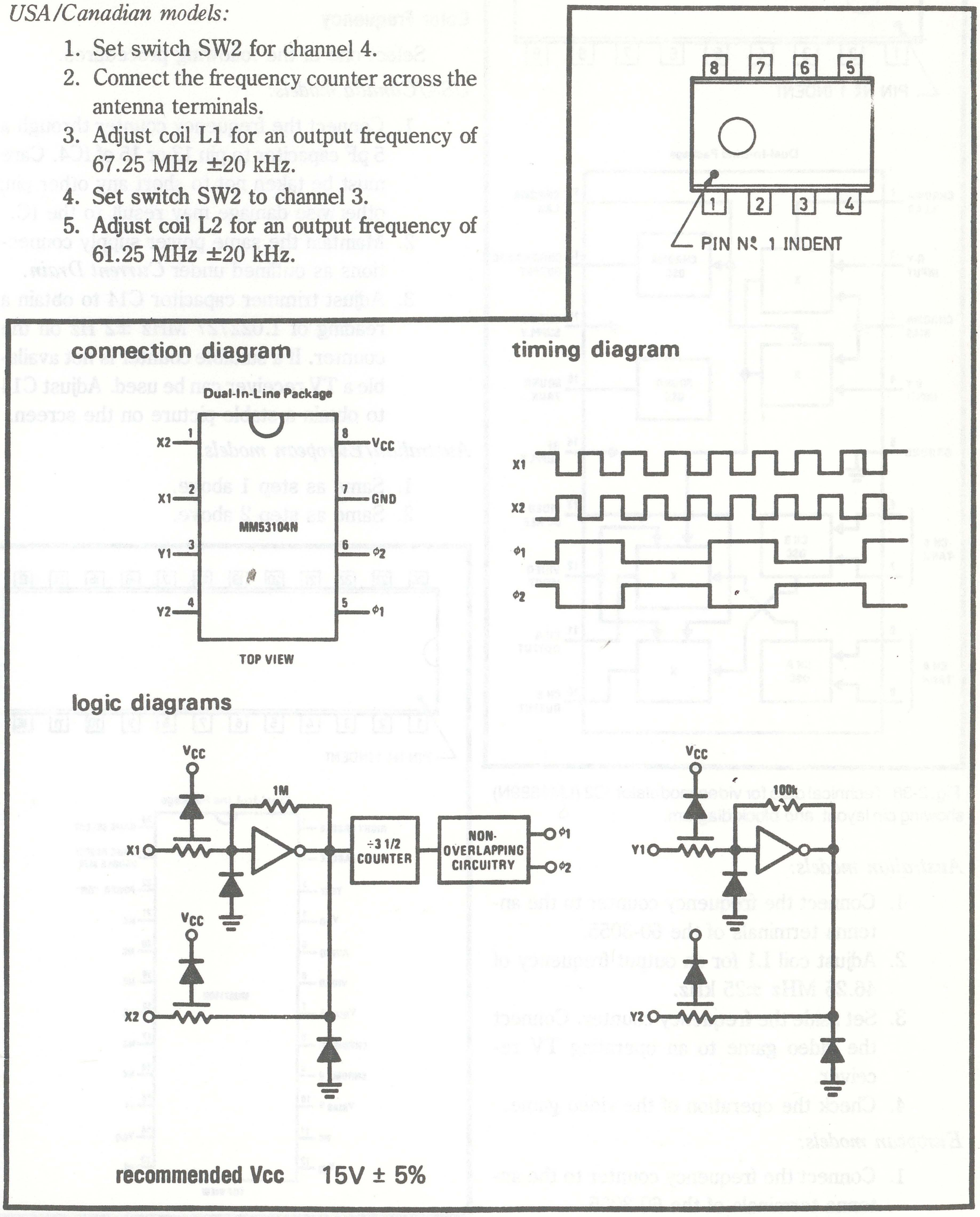



Fig. 2-37. Technical data for clock generator IC3 (MM53104) showing connection diagram, pin layout, timing waveforms, and logic diagrams.

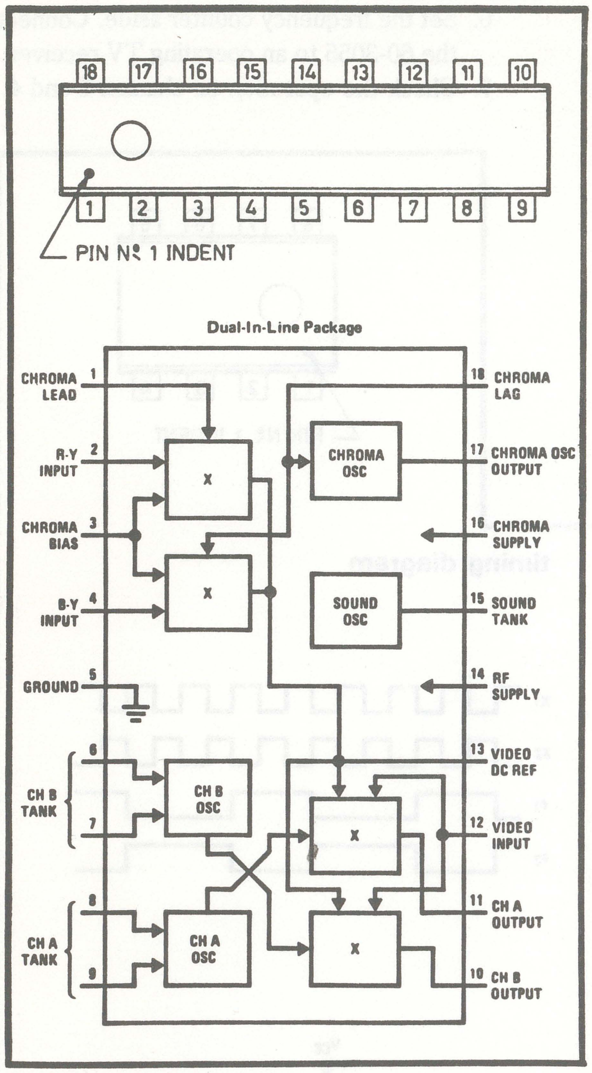



Fig. 2-38. Technical data for video modulator IC2 (LM1889N) showing pin layout and block diagram.

*Australian models:*

1. Connect the frequency counter to the antenna terminals of the 60-3055.
2. Adjust coil L1 for an output frequency of 46.25 MHz ±25 kHz.
3. Set aside the frequency counter. Connect the video game to an operating TV receiver.
4. Check the operation of the video game.

*European models:*

1. Connect the frequency counter to the antenna terminals of the 60-3055.
2. Adjust coil L1 for an output frequency of 62.25 MHz ± 25 kHz.
3. Set aside the frequency counter. Connect the video game to an operating TV receiver.
4. Check the operation of the video game.

**Color Frequency**

Select one of the following procedures.

*USA/Canada models:*

1. Connect the frequency counter through a 5 pF capacitor to pin 13 or 15 of IC4. Care must be taken not to short any other pin; otherwise damage may result to the IC.
2. Maintain the same power supply connections as outlined under *Current Drain*.
3. Adjust trimmer capacitor C14 to obtain a reading of 1.022727 MHz ±2 Hz on the counter. If a suitable counter is not available a TV receiver can be used. Adjust C14 to obtain a stable picture on the screen.

*Australian/European models:*

1. Same as step 1 above.
2. Same as step 2 above.

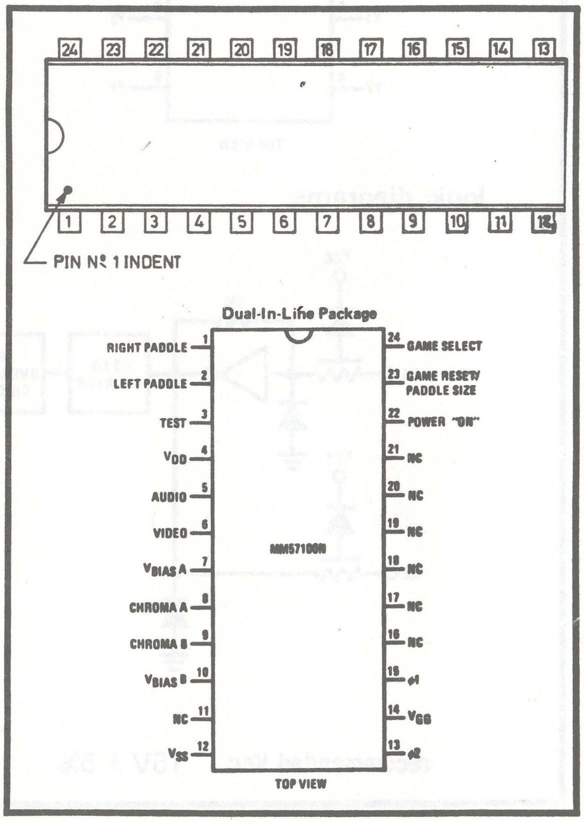



Fig. 2-39. Pin layout and connection diagram for game chip IC4 (MM57100N).

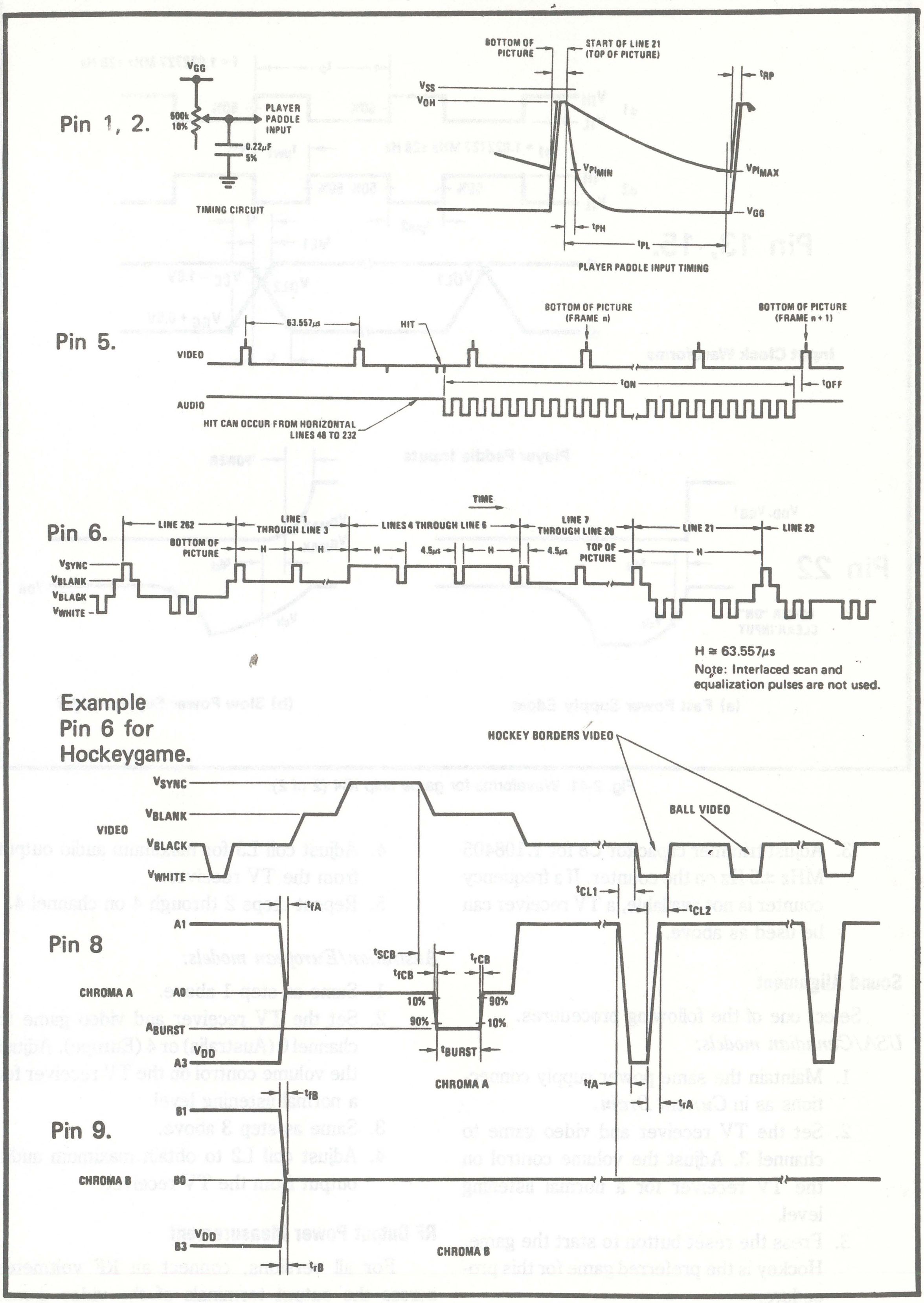



Fig. 2-40. Waveforms for game chip IC4 (1 of 2).

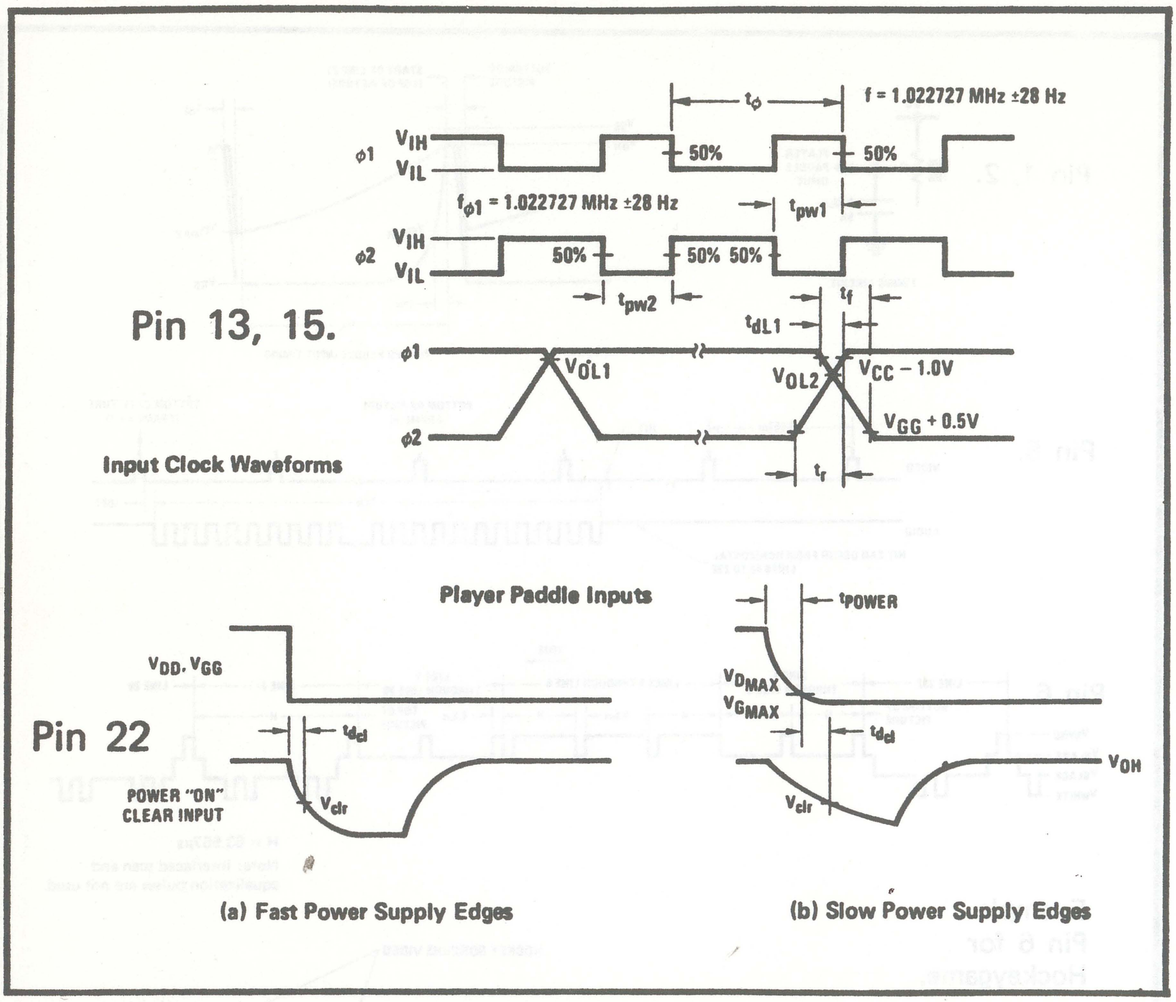



Fig. 2-41. Waveforms for game chip IC4 (2 of 2).

3. Adjust trimmer capacitor C8 for 1.108405 MHz ±5 Hz on the counter. If a frequency counter is not available, a TV receiver can be used as above.

## Sound Alignment

Select one of the following procedures.

*USA/Canadian models:*

1. Maintain the same power supply connections as in *Current Drain*.
2. Set the TV receiver and video game to channel 3. Adjust the volume control on the TV receiver for a normal listening level.
3. Press the reset button to start the game. Hockey is the preferred game for this procedure.
4. Adjust coil L3 for maximum audio output from the TV receiver.
5. Repeat steps 2 through 4 on channel 4.

*Australian/European models:*

1. Same as step 1 above.
2. Set the TV receiver and video game to channel 0 (Australia) or 4 (Europe). Adjust the volume control on the TV receiver for a normal listening level.
3. Same as step 3 above.
4. Adjust coil L2 to obtain maximum audio output from the TV receiver.

## RF Output Power Measurement

For all versions, connect an RF voltmeter across the output terminals of the video game.

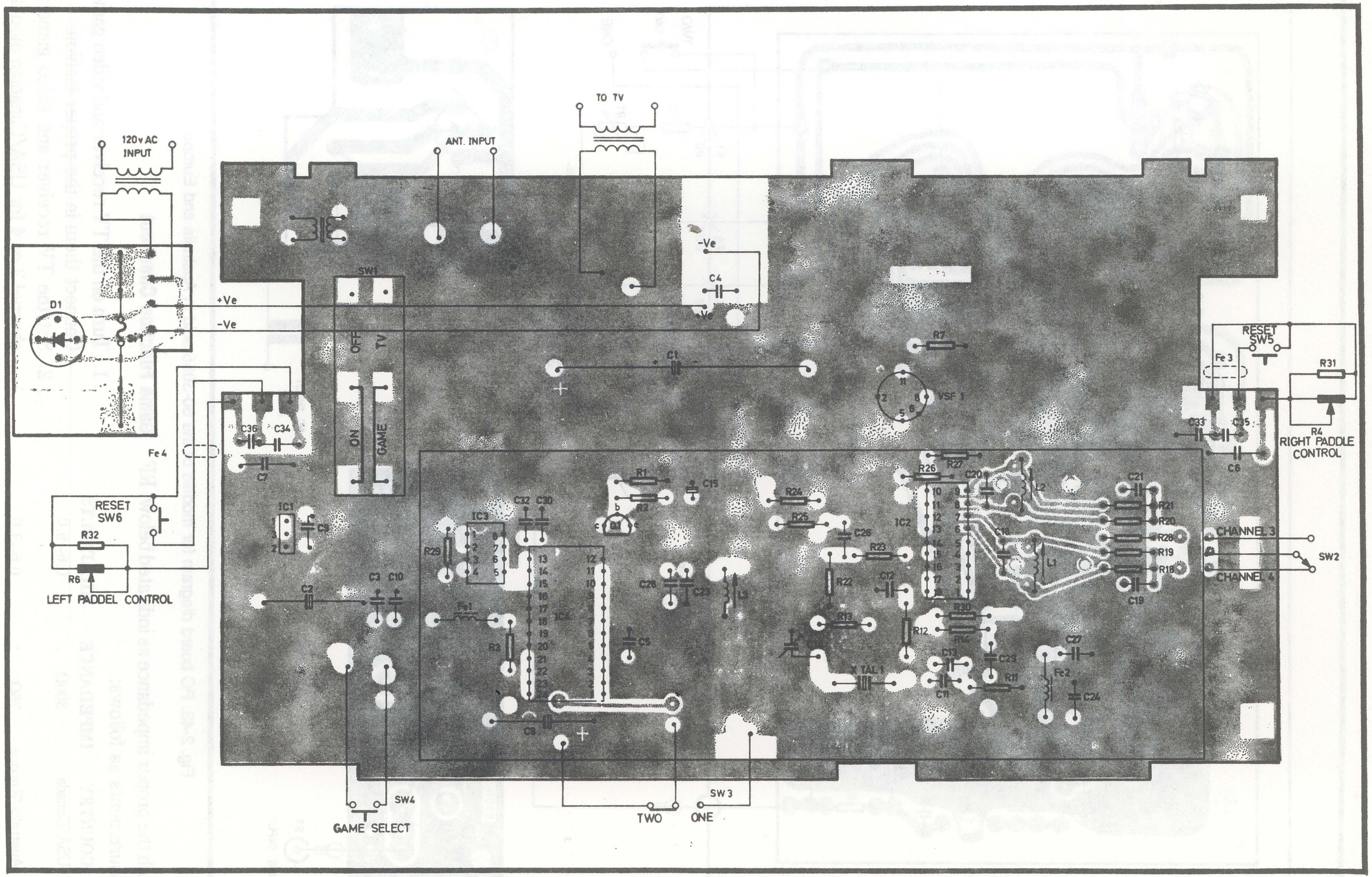



Fig. 2-42. PC board diagram of the 60-3055 video game sold in the USA and Canada.

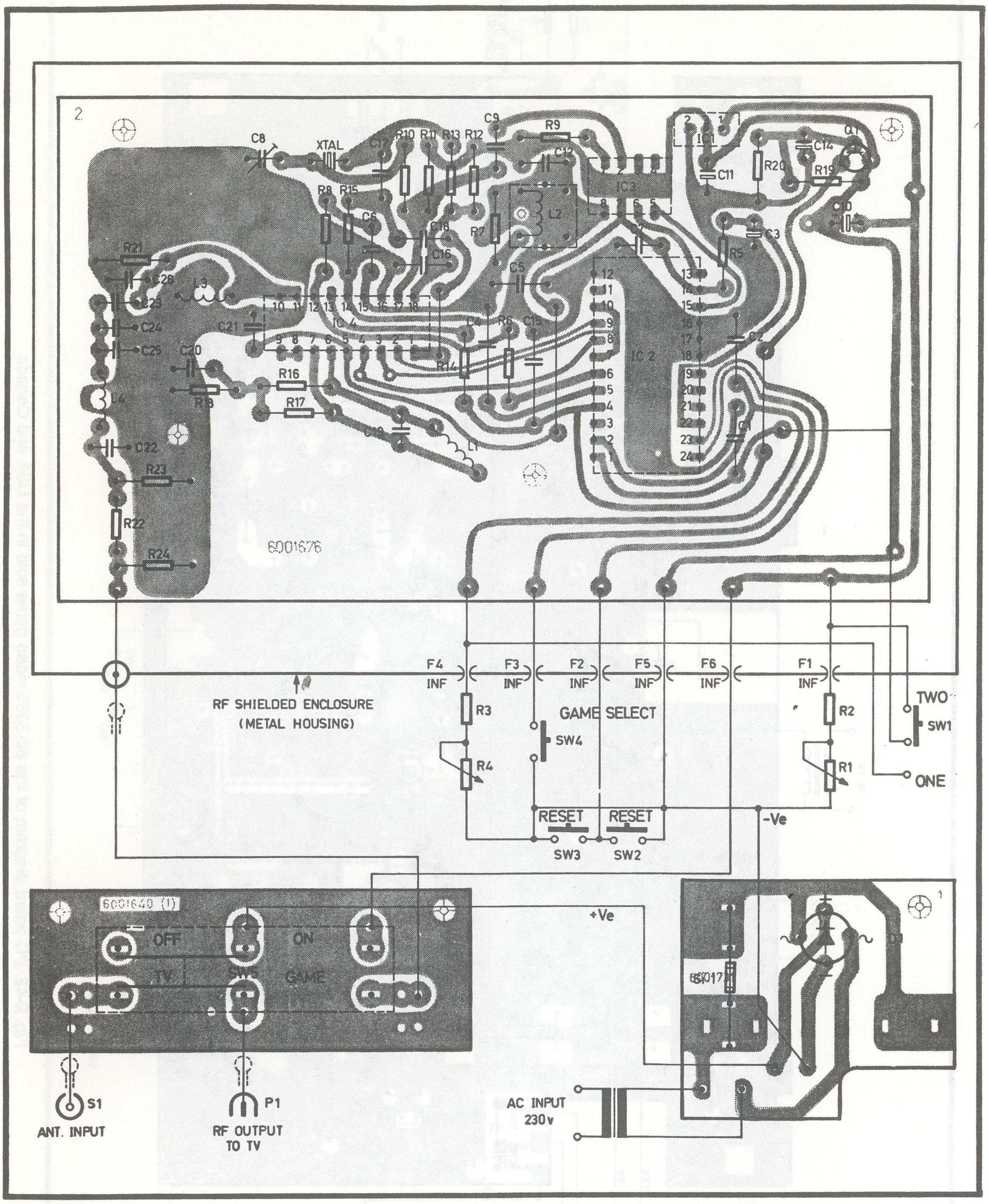



Fig. 2-43. PC board diagram for models of the 60-3055 sold in Australia and Europe.

Match the proper impedance as indicated below. RF measurements as follows:

| COUNTRY | IMPEDANCE | MILLIVOLTS |
|---|---|---|
| USA/Canada | 300Ω | 0.6–5.0 |
| Australia/Europe | 75Ω | 0.6–3.0 |

## Game Function Checkout

1. Turn on the TV receiver and video game. Connect them in the proper fashion.
2. Set the TV receiver and video game to channel 3 or 4 for USA/Canadian models,

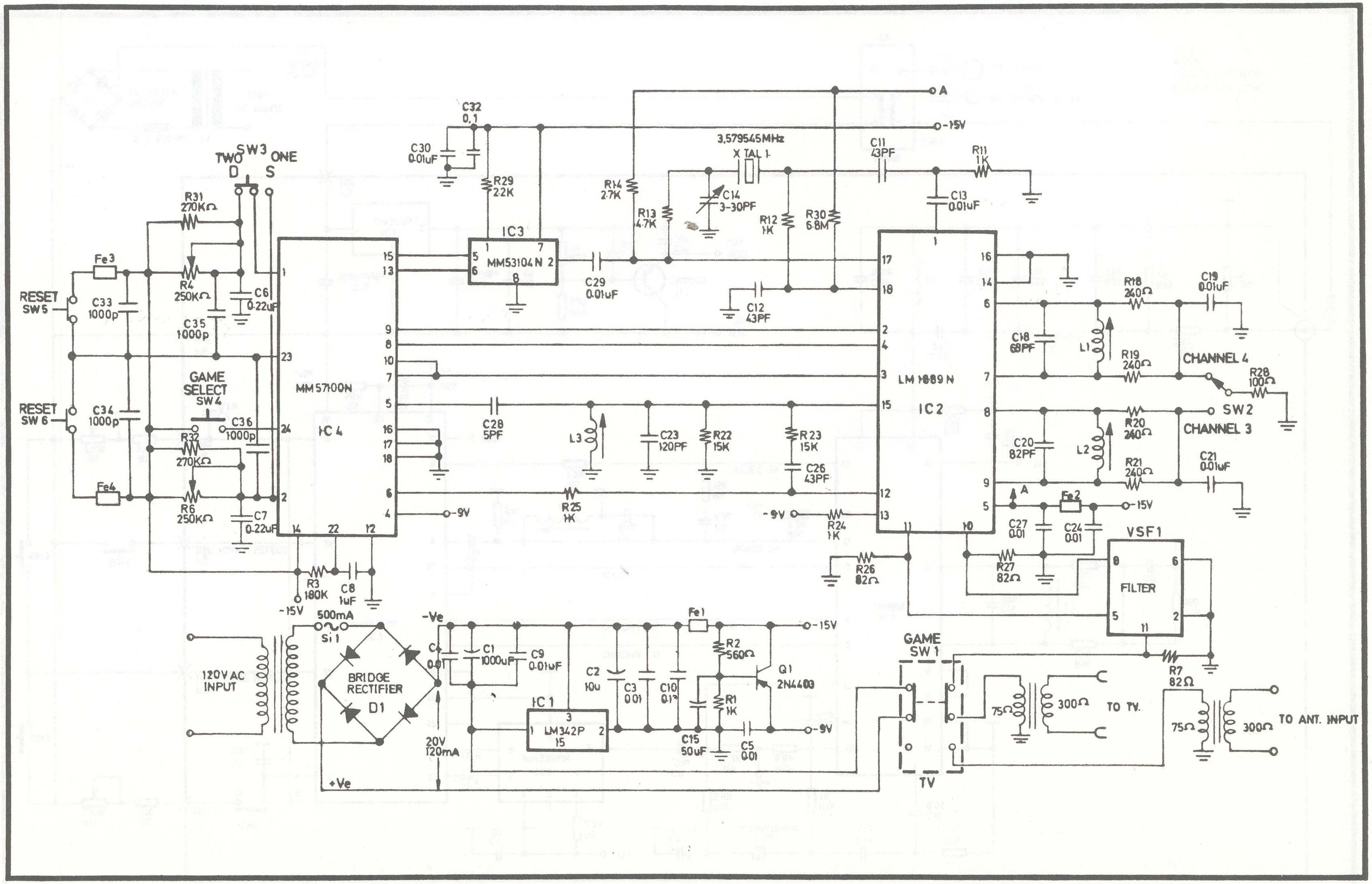



Fig. 2-44. Schematic diagram for models of the 60-3055 sold in the USA and Canada.

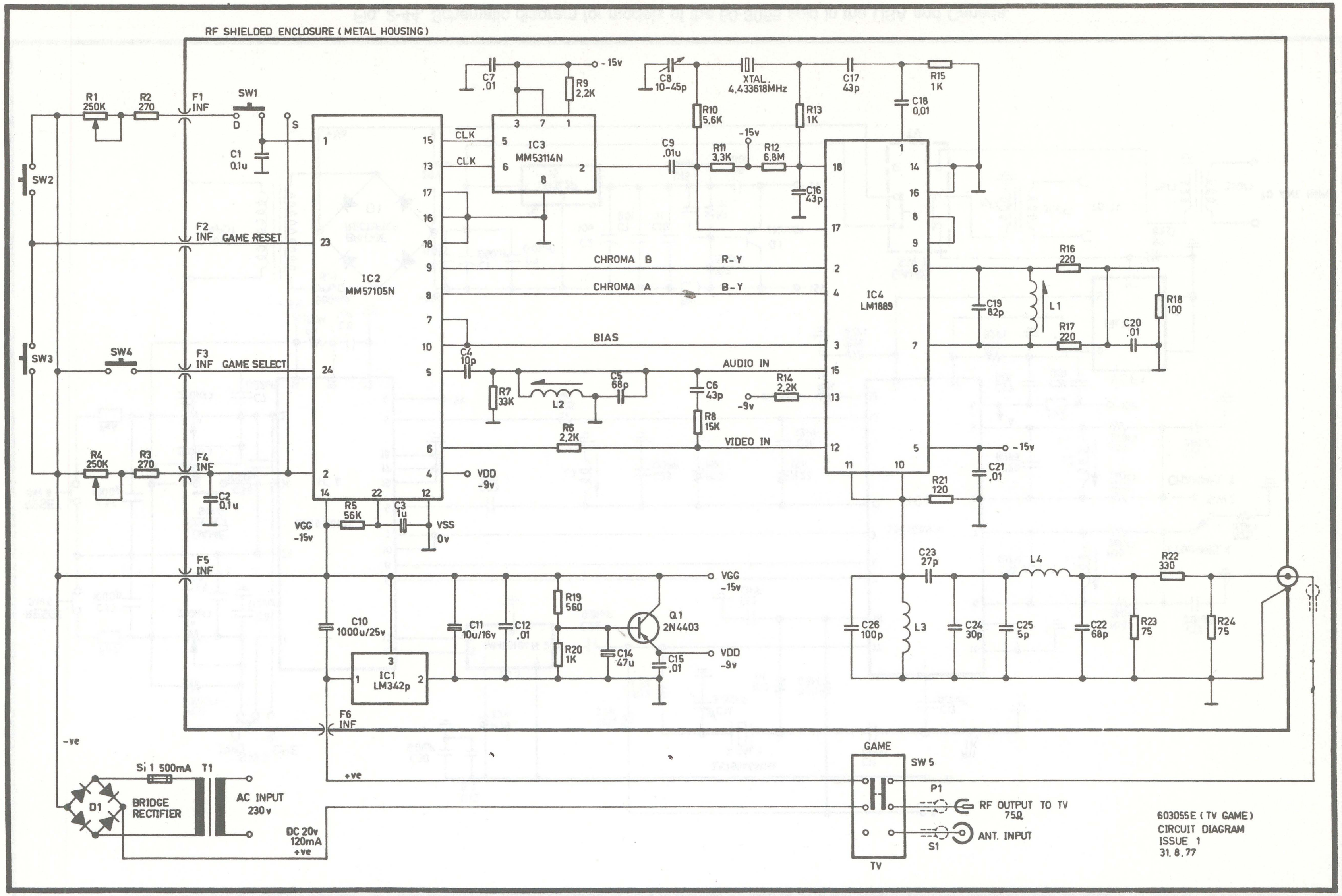



**Fig. 2-45. Schematic diagram for models of the 60-3055 video game sold in Australia and Europe.**

| Ref. No. | Description | RS No. | MF. No. | Ref.No. (2) | Description | RS No. | Mfr. No. |
|---|---|---|---|---|---|---|---|
| **Capacitor** | | | | | | | |
| C1 | Electrolytic Cap. 1000 MF/25V | | 5230533 | | | | |
| C2 | Electrolytic Cap. 10 MF/25V | | 5230089 | C26 | Ceramic Cap, 43 PF/50V | | 5200851 |
| C3 | Ceramic Cap. 0.01 MF/25V | | 5202112 | C27 | Ceramic Cap. 0.01 MF. 25V | | 5202112 |
| C4 | Ceramic Cap. 0.01 MF/25V | | 5202112 | C28 | Ceramic Cap. 5 PF/50V | | 5200191 |
| C5 | Ceramic Cap. 0.01 MF/25V | | 5202112 | C29 | Ceramic Cap. 0.01 MF/25V | | 5202112 |
| C6 | Polyester Cap. 0.22 MF/50V | | 5220333 | C30 | Ceramic Cap. 0.01 MF/25V | | 5202112 |
| C7 | Polyester Cap. 0.22 MF/50V | | 5220333 | | | | |
| C8 | Electrolytic Cap. 1 MF/16V | | 5230041 | C32 | Ceramic Cap. 0.1 MF/25V | | 5201661 |
| C9 | Ceramic Cap. 0.01 MF/25V | | 5202112 | C33 | Ceramic Cap. 1000 PF 25V | | 5201351 |
| C10 | Ceramic Cap. 0.1 MF/25V | | 5201661 | C34 | Ceramic Cap. 1000 PF 25V | | 5201351 |
| C11 | Ceramic Cap. 43 PF/50V | | 5200851 | C35 | Ceramic Cap. 1000 PF 25V | | 5201351 |
| C12 | Ceramic Cap. 43 PF/50V | | 5200851 | C36 | Ceramic Cap. 1000 PF 25V | | 5201351 |
| C13 | Ceramic Cap. 0.01 MF/25V | | 5202112 | | | | |
| C14 | Variable Cap. | C-4637 | 5260355 | | **Bridge Rectifier** | | |
| C15 | Cap. Elect. 50MF 15V | | 5230168 | D1 | Bridge Rectifier | | 5030037 |
| | | | | | **Ferrite Bead** | | |
| | | | | FC1 | Ferrite Bead | | 6530061 |
| C18 | Ceramic Cap. 68 PF/50V | | 5201739 | FC2 | Ferrite Bead | | 6530061 |
| C19 | Ceranic Cap. 0.01 MF/25V | | 5202112 | FC3 | Ferrite Bead | | 6530061 |
| C20 | Ceramic Cap. 82 PF/50V | | 5201791 | FC4 | Ferrite Bead | | 6530061 |
| | | | | | Insulating Sheet | | 6541378 |
| C21 | Ceramic Cap. 0.01 MF/25V | | 5202112 | **Integrated Circuit** | | | |
| | | | | IC1 | Integrated Circuit LM342P-15 | MX-3262 | 5040092 |
| C23 | Ceramic Cap. 120 PF/50V | | 5201053 | IC2 | Integrated Circuit LM1889M | MX-3263 | 5040109 |
| C24 | Ceramic Cap. 0.01 MF/25V | | 5202112 | IC3 | Integrated Circuit MM53104N | MX-3264 | 5040110 |
| | | | | IC4 | Integrated Circuit MM57100N | MX-3266 | 5040122 |
| | | | | | Socket for IC (18 Pin) | | 6200419 |
| | | | | | Socket for IC (24 Pin) | | 6200420 |

Fig. 2-46. Electrical parts list for models of the 60-3055 sold in the USA and Canada (1 of 2).

| Ref. No. | Description | RS No. | Mf. No. | Ref.No. | Description | Rs No. | Mf. No. |
|---|---|---|---|---|---|---|---|
| **Coil** | | | | | | | |
| L1 | Coil, VHF/RF | CA-4884 | 5300780 | R28 | Resistor 100 ohm<br>1/4 W ±5% | NEE-0132 | 5103108 |
| L2 | Coil, VHF/RF | CA-4884 | 5300780 | | | | |
| L3 | Coil, VHF/RF | CA-4885 | 5300792 | R29 | Resistor 2.2K ohm<br>1/4 W ±5% | NEE-0216 | 5104228 |
| **Transistor** | | | | R30 | Resistor 6.8 ohm<br>1/4 W ±10% | | 5117685 |
| Q1 | Transistor 2N4403 | | 5021449 | | | | |
| **Resistor** | | | | R31 | Resistor 270K ohm<br>1/4 W ±5% | NEE-0402 | 5106274 |
| R1 | Resistor 1K ohm<br>1/4 W ±5% | NEE-0196 | 5104101 | R32 | Resistor 270K ohm<br>1/4 W ±5% | NEE-0402 | 5106274 |
| R2 | Resistor 560 ohm<br>1/4 W ±5% | NEE-0176 | 5103561 | **Fuse** | | | |
| R3 | Resistor 180K ohm<br>1/4 W ±5% | NEE-0387 | 5106183 | SI1 | Fuse, 500 mA | | 6700203 |
| | | | | **Switch** | | | |
| R4 | Resistor, Var. | S-0808 | 5140671 | SW1 | Switch on/off | S-0816 | 6100722 |
| R6 | Resistor, Var. | S-0808 | 5140671 | SW2 | Switch, Ch. select. | S-0817 | 6100734 |
| R7 | Resistor 82 ohm<br>1/4 W ±5% | NEE-0122 | 5102827 | SW3 | Switch, Slide | S-2411 | 6100746 |
| R11 | Resistor 1K ohm<br>1/4 W ±5% | NEE-0196 | 5104101 | **Filter** | | | |
| R12 | Resistor 1K ohm<br>1/4 W ±5% | NEE-0196 | 5104101 | VSF1 | Filter, vest. side<br>band | C-8303 | 5060005 |
| R13 | Resistor 4.7K ohm<br>1/4 W ±5% | NEE-0247 | 5104472 | X'TAL1 | Crystal<br>3.57945 MHZ | MX-2327 | 5060017 |
| | | | | **Transformer** | | | |
| R14 | Resistor 2.7K ohm<br>1/4 W ±5% | NEE-0224 | 5104227 | Power | Transformer' | TA-0635 | 5400775 |
| R18 | Resistor 240 ohm<br>1/4 W ±5% | | 5103248 | | Transformer, Balun | CA-3825 | 5410343 |
| | | | | **P.C.B.** | | | |
| R19 | Resistor 240 ohm<br>1/4 W ±5% | | 5103248 | | Main P.C.B. | X-7547 | 60001573 |
| R20 | Resistor 240 ohm<br>1/4 W ±5% | | 5103248 | | Power Supply P.C.B. | X-7548 | 6001585 |
| | | | | **Wire & Cord** | | | |
| R21 | Resistor 240 ohm<br>1/4 W ±5% | | 5103248 | | Bare Wire | | 6300051 |
| | | | | | Wire, Standed (Red) | | 6320116 |
| R22 | Resistor 15K ohm<br>1/4 W ±5% | NEE-0277 | 5105154 | | Wire, Standed (White) | | 6320189 |
| | | | | | Line Cord | W-1957 | 6360175 |
| R23 | Resistor 15K ohm<br>1/4 W ±5% | NEE-0277 | 5105154 | | Symmetrical Feeder | HB-6779 | 6390003 |
| R24 | Resistor 1K ohm<br>1/4 W ±5% | NEE-0196 | 5104101 | | Symmetrical Feeder | HB-6827 | 6390003 |
| | | | | | Coaxial Cable 75 ohm | W-1958 | 6390052 |
| R25 | Resistor 1 K ohm<br>1/4 W ±5% | NEE-0196 | 5104101 | | Cord, 3 core | | 6390064 |
| | | | | | Wire, Shielded (Brown) | | 6330018 |
| R26 | Resistor 82 ohm<br>1/4 W ±5% | NEE-0122 | 5102827 | | Wire, Standed (Black) | | 6320025 |
| | | | | | Wire, Standed (Blue) | | 6320153 |
| R27 | Resistor 82 0hm<br>1/4 W ±5% | NEE-0122 | 5102827 | | Wire, Standed (Green) | | 6320141 |

Fig. 2-47. Electrical parts list for models of the 60-3055 sold in the USA and Canada (2 of 2).

| Ref. No. | Description | RS No. | Mf. No. | Ref. No. | Description | RS No. | Mf. No. |
|---|---|---|---|---|---|---|---|
| | Cabinet Bottom | Z-3703 | 0104256 | | Wire Joint | | 0690382 |
| | Controller Cab. Btm. (Right) | Z-3704 | 0104271 | | Shield Can Cover | HB-6772 | 0660286 |
| | Controller Cab. Btm. (Left) | Z-3705 | 0104293 | | Shield Can Bottom | HB-6773 | 0660298 |
| | Controller Cab. Top (Right) | Z-3706 | 0104414 | | Terminal | | 0690096 |
| | Controller Cab. Top (Left) | Z-3707 | 0104426 | | Terminal | J-4513 | 0690023 |
| | Cabinet Top | Z-3708 | 0104441 | | Terminal, U-Shape | J-4514 | 0690813 |
| | Cover Plate | HB-6756 | 0151271 | | Terminal, Ant. | J-4515 | 0690928 |
| | Switch Cover Plate | | 0151349 | | Metal Wire for knob | HB-6774 | 0690965 |
| | Mounting Plate | HB-6758 | 0203077 | | | | |
| | Foot | | 0520347 | | | | |
| | Spacer | HB-6760 | 0520293 | | | | |
| | Fuse Holder | F-1129 | 0530471 | | | | |
| | Filler | | 0540814 | | | | |
| | Masking Scrim | HB-6761 | 0540671 | | | | |
| | Cord Winder | HB-6762 | 0590222 | | | | |
| | Screw M3 x 14 | | 0600411 | | | | |
| | Screw M3 x 0.5P x 8 | | 0600228 | | | | |
| | Screw M3 x 0.5P x 5 | | 0600174 | | | | |
| | Screw M3 x 10 | | 0600198 | | | | |
| | Screw M3 x 10 | | 0600381 | | Knob, Game Select | K-2693 | 3203152 |
| | Screw M2.6 x 6 | | 0600824 | | Knob, On/Off | K-2694 | 3203164 |
| | Screw M3 x 6 | | 0600046 | | Knob, Slide Control | K-2695 | 3203255 |
| | Screw M2 x 5 | | 0600976 | | Knob, Push Button | K-2696 | 3203267 |
| | Screw M3 x 6 | | 0600046 | | Fibre Sleeving | | 2510008 |
| | Washer, Lock | | 0610179 | | Fibre Sleeving | | 2510011 |
| | Washer, steel | | 0610261 | | Tape, Tesa 354 | | 2300152 |
| | Stud | | 0620902 | | Heat Shrinkable Tube | | 2540050 |
| | Screw M3 x 0.5P x 8 | | 0600514 | | Fibre Sleeving | | 2510033 |
| SW4/5/6 | Contact Plate | HB-6763 | 0631146 | | Insulation Sheet | | 6541366 |
| SW4 | Contact Spring Strip | HB-6764 | 0631161 | | Foil, Hot Stamping | | 3500228 |
| SW5/6 | Contact Spring Strip | HB-6765 | 0631201 | | | | |
| | Clamp, Cable | HB-6766 | 0640275 | | | | |
| | Heat Sink | HH-0241 | 0650323 | | | | |
| | Insulation Sheet | | 6541354 | | | | |
| | Shield Can | HB-6768 | 0660201 | | | | |
| | Shield Can | | 0660213 | | | | |
| | Shield Can | HB-6769 | 0660225 | | | | |
| | Shield Can | HB-6770 | 0660237 | | | | |
| | Shield Foil | HB-6771 | 0660262 | | | | |

Fig. 2-48. Mechanical parts list of the 60-3055 for all versions.

| Ref. No. | Description | TE P/N | Ref. No. | Description | TE P/N |
|---|---|---|---|---|---|
| R1, 2 | Var. Resistor (B) 250K | 5140671 | C22 | 68pf (For European) | 5201739 |
| R3, 4 | 270 ohm ¼W ±5% | 5103273 | C23 | 27pf 50V | 5202185 |
| R5 | 56K | 5105567 | C24 | 30pf 25V | 5200701 |
| R6 | 2.2K | 5104228 | C25 | 5pf 50V | 5200191 |
| R7 | 33K | 5105336 | C26 | 130pf 25V (For Australia) | 5202215 |
| R8 | 15K | 5105154 | C26 | 100pf (For European) | 5202 |
| R9 | 2.2K | 5104228 | C27, 28, | Cap. feed-through 1000pf | 5270002 |
| R10 | 5.6K | 5104563 | C29, 30, | | |
| R11 | 3.3K | 5104332 | C31, 32, | | |
| R12 | 6.8M | 5117685 | C33. | | |
| R13 | 1K | 5104101 | Q1 | PNP Transistor 2N4403 | 5021449 |
| R14 | 2.2K | 5104228 | Ic1 | LM342P-15 | 5040092 |
| R15 | 1K | 5104101 | IC2 | MM57105N | 5040146 |
| R16 | 220 | 5103224 | IC3 | MM53114N | 5040134 |
| R17 | 220 | 5103224 | IC4 | LM1889M | 5040109 |
| R18 | 100 | 5103108 | IC Socket | 24 pins | 5200420 |
| R19 | 560 | 5103561 | IC Socket | 18 pins | 6200419 |
| R20 | 1K | 5104101 | D1 | Bridge rectifier | 5030037 |
| R21 | 120 | 5103121 | | Crystal, 4.433618 MHz | 5060029 |
| R22 | 330 | 5103339 | | | |
| R23 | 75 | 5102751 | | Fuse, 500ma. | 6700203 |
| R24 | 75 | 5102751 | | Switch, on/off | 6100722 |
| | | 5220448 | | Switch, Slide | 6100746 |
| | | 6220448 | | | |
| C1 | 0.1uf (50V) | 5230132 | | Transformer, | 5400817 |
| C2 | 0.1uf (50V) | 5202227 | | Line Cord | 6360187 |
| C3 | 1uf (50V) | 5201739 | | Wire, Joint | 0690382 |
| C4 | 1opf (NPO) | 5200851 | | P.C.B. Main | 6001676 |
| C5 | 68pf (50V) | 5202112 | | P.C.B. Isolate Board | 6001640 |
| C6 | 43pf (50V) | 5260355 | | P.C.B. Power Supply | 6001731 |
| C7 | 0.01uf 25V | 5202112 | | Transformer (European version) | 5400829 |
| C8 | V. C. | 5230545 | | | |
| C9 | 0.01uf 25V | 5230740 | | | |
| C10 | 1000uf 25V | 5202112 | | **COIL (FOR AUSTRALIA)** | |
| C11 | 10uf 16V | 5202112 | L1 | V.H.F. Coil | 5300871 |
| C12 | 0.01uf 25V | 5230168 | L2 | V.H.F. Coil | 5300883 |
| C13 | 0.01uf 25V | 5202112 | L3 | Filter Coil | 5320331 |
| C14 | 50uf 15V | 5200851 | L4 | Filter Coil | 5320341 |
| C15 | 0.01uf 25V | 5200851 | | **COIL (FOR EUROPEAN)** | |
| C16 | 43pf 50V | 5202112 | | | |
| | | 5201791 | L1 | V.H.F. Coil | 5300809 |
| C20 | 0.01uf 25V | 5202112 | L2 | V.H.F. Coil | 5300883 |
| C21 | 0.01uf 25V | 5202112 | L3 | Filter Coil | 5320353 |
| C22 | 82pf 50V (For Australia) | 5201791 | L4 | Filter Coil | 5320365 |

Fig. 2-49. Electrical parts list for models of the 60-3055 sold in Australia and Europe.

to channel 4 for European models, or to channel 0 for Australian models. A game pattern should appear.

3. Push the game select switch. There should be a game change each time it is touched, totalling three different patterns.
4. Set the players switch to the two. Slide the paddle control knobs to check for movement along the TV screen, right control governing right paddle and left control governing left paddle.
5. Set the players switch to the one position. The left control should govern both players at the same time.
6. Push the reset switch. A new game should start and automatically count the score.
7. Repeat steps 3 through 6 to test other games.
8. Change the player size by moving the player to either top or bottom border. Press the reset switch once; the player/paddle size should change. There are three sizes available.

### REPLACEMENT PARTS

There are two electrical parts lists shown on the following pages. One for USA/Canadian models and one for Australian/European models. Both of the electrical parts lists refer to components by schematic symbols. The parts list for USA/Canada contains two part number columns. One of these columns indicates an in-house Radio Shack number and the other shows a manufacturer's number. When ordering replacement parts, indicate both part numbers when given in the parts list. The Australian and European parts list, however, lists only one part number. In addition, a mechanical parts list is provided for hardware items, such as knobs, cabinet parts, and screws, which applies to all versions. When ordering replacement parts from this list through overseas outlets use the part number shown in the *Mf. No.* column. Parts lists are as follows:

| PARTS LIST | FIGURE |
|---|---|
| Electrical parts—USA/Canada | 2-46 & 2-47 |
| Mechanical parts—all versions | 2-48 |
| Electrical parts—Australia/Europe | 2-49 |

## TV SCOREBOARD MODEL 60-3056

This model is similar to TV Scoreboards 60-3051 and 60-3054. Refer to the section covering the 60-3051 to understand the operation of the circuitry.

Instead of the PC board being mounted to the top plastic case, this model has it mounted on the bottom half. To remove the top case, remove the two screws on the bottom side of the paddle cradle. Perform the disassembly step in the following sequence: (1) remove the main PC board screws, (2) remove the two modulator PC board screws, (3) remove the battery door by bowing it slightly, (4) remove the two battery holder screws, (5) finally, slide the battery holder out through the slot provided in the bottom of the case.

To open the plastic paddle cases, (1) remove the one screw at the bottom, (2) open the plastic case, noting the lead dress, (3) then push the control lever from the top. The pot will come out with the control lever.

### CIRCUIT DIFFERENCES

The following paragraphs explain the circuit differences between this model and the 60-3054. Both the 60-3054 and 60-3056 are similar to the 60-3051. A schematic diagram of the 60-3056 is shown in Fig. 2-50.

#### Power Supply

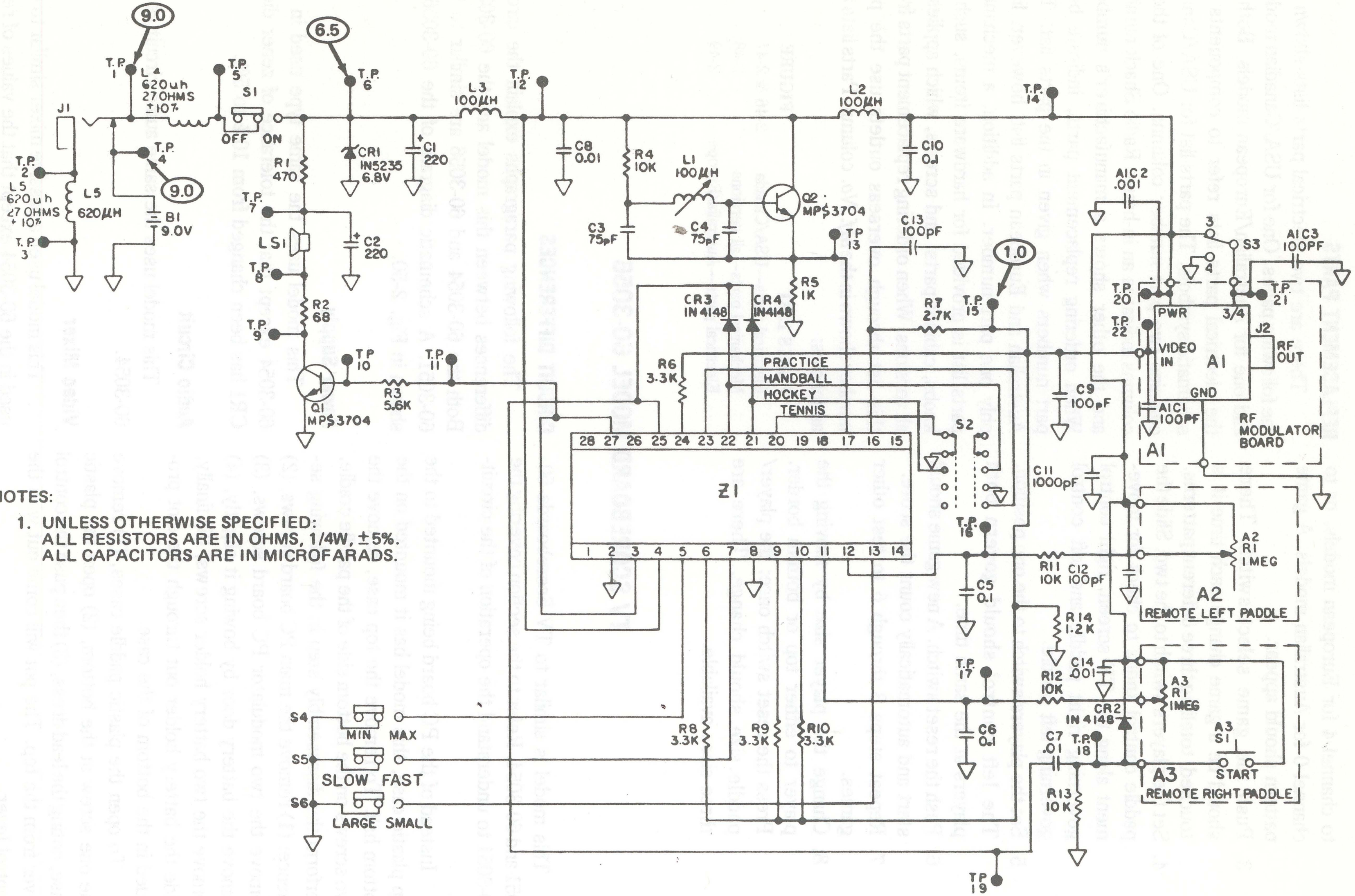
This model uses the same type used in the 60-3054 except that the tolerance of zener diode CR1 has been changed from 10% to 5%.

#### Audio Circuit

This model uses the same audio circuit as the 60-3054.

#### Video Mixer

This model used a passive mixer similar to that used in the 60-3054 except that the values of resis-




NOTES:

1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
ALL CAPACITORS ARE IN MICROFARADS.

Fig. 2-50. Schematic diagram of the 60-3056 video game. Operation of this game is similar to the 60-3051 game.

tors R6, R7, R8, R9, and R10 have been changed. They have been changed from 4.7K to 3.3K with the exception of R7; this resistor is now 2.7K.

### Modulator

Basically, this model uses the same modulator as in the 60-3054 with external differences. Replace the modulator only with part number 1700064.

### Master Oscillator

Same as 60-3054. Use the same adjustment method.

### Reset Logic

Same as the 60-3054.

### Option Switches

Same as the 60-3054.

### Paddle Controls

Same as the 60-3054. See *Paddle Test & Adjustment*.

## PADDLE TEST & ADJUSTMENT

As you can see, the paddle controls are of the same type as the 60-3054 game except for mechanical mounting. The lever used on the pot's shaft must be adjusted to insure that the paddle symbol on the screen will go completely off the screen at both lever extremes. The lever is pressed on the pot's shaft. To adjust, do the following:

1. Press the lever on the pot. Make sure the pot's terminals are pointed in the same direction as before disassembly in reference to the lever.
2. Insure that the lever is in the correct position by temporarily inserting the pot and lever in the top case. The lever should move in the case without binding. The pot should rest in the plastic anchor in the top paddle case.
3. Once step 2 is satisfactory, turn on the TV game and watch the screen while varying the lever to its forward and backward stops.
4. The paddle symbol should go completely off the top and bottom of the screen.
5. Notice that on the back side of the pot there is a screwdriver slot in the nylon shaft end (opposite that where the lever is pressed on the pot).
6. Move the lever full forward. Using a screwdriver, turn the pot shaft while holding the lever against its forward stop. Adjust the pot so that the paddle symbol just disappears off the top of the screen. Move the lever to its backward stop and see if the paddle goes off the bottom of the screen.
7. Reassemble the paddle plastic insuring that lead dress does not interfere with the lever motion, or that leads will not be damaged by screw insertion.

You can make an adjustment fixture out of a paddle top. Cut a hole or slot in a top, so that you can turn the pot from the backside at the same time the pot is seated in the supports. Once it is adjusted in your fixture, the pot should work properly in its own plastic top.

Notice that the paddle position on the screen is temperature sensitive. For a given paddle position, the paddle symbol will drift up with an increase in temperature. Because of this fact, the paddle adjustment should be made under normal room temperature. If the game has been stored in a hot or cold area, allow some time for the unit to achieve room temperature.

There may be cases where the paddle symbols, particularly the left paddle, will not go off the bottom or the top of the screen even after extensive adjustment. Insert a 0.22 $\mu$F capacitor across the pot's active terminals to see if this helps. If not, replace the main chip, Z1.

## REPLACEMENT PARTS

The parts list for the 60-3056 TV Scoreboard is shown in Fig. 2-51. Entries shown under the *Symbol* column are keyed to the schematic diagram in Fig. 2-50. When ordering replacement parts, give the model number, symbol designation, description, and part number. Address orders to the location indicated at the beginning of this chapter.

| SYMBOL | DESCRIPTION | PART NUMBER |
|---|---|---|
| | ELECTRICAL | |
| A1 | Assembly, electronics | 1700064 |
| A1C1 | 100pF Capacitor, Disc | 992-0182 |
| A1C2 | 0.001 μF Capacitor, Disc | 992-0022 |
| A1C3 | 100pF Capacitor, Disc | 992-0182 |
| A2R1 | 1 Megohm Pot, Linear Taper | 996-0632 |
| A3R1 | 1 Megohm Pot, Linear Taper | 996-0632 |
| A3S1 | Pushbutton Switch | 996-0088 |
| C1 | 220 μF Capacitor, Electrolytic | 992-0183 |
| C2 | 220 μF Capacitor, Electrolytic | 992-0183 |
| C3 | 75pF Capacitor, Disc | 992-0163 |
| C4 | 75pF Capacitor, Disc | 992-0163 |
| C5 | 0.1 μF Capacitor, Disc | 992-0157 |
| C6 | 0.1 μF Capacitor, Disc | 992-0157 |
| C7 | 0.01 μF Capacitor, Disc | 992-0046 |
| C8 | 0.01 μF Capacitor, Disc | 992-0046 |
| C9 | 100pF Capacitor, Disc | 992-0182 |
| C10 | 0.1 μF Capacitor, Disc | 992-0157 |
| C11 | 0.001 μF Capacitor, Disc | 992-0022 |
| C12 | 100pF Capacitor, Disc | 992-0182 |
| C13 | 100pF Capacitor, Disc | 992-0182 |
| CR1 | Zener Diode, 6.8V, 5% | 994-0602 |
| CR2 | IN4148 Diode, Silicon | 994-0588 |
| CR3 | IN4148 Diode, Silicon | 994-0588 |
| CR4 | IN4148 Diode, Silicon | 994-0588 |
| J1 | Jack, Subminiature | 997-0461 |
| L1 | 100 μH Coil, Variable | 993-0035 |
| L2 | 100 μH Coil, Peaking | 993-0034 |
| L3 | 100 μH Coil, Peaking | 993-0034 |
| L4 | 620 μH Coil, Peaking | 993-0036 |
| L5 | 620 μH Coil, Peaking | 993-0036 |
| LS1 | 8 ohm, 0.2W Speaker | 995-0070 |
| Q1 | Transistor, Amplifier, Silicon, NPN, MPS3704 | 994-0524 |
| Q2 | Transistor, Amplifier, Silicon, NPN, MPS3704 | 994-0524 |
| R1 | 470 ohm, Resistor, 1/4W | 991-0883 |
| R2 | 68 ohm, Resistor, 1/4W | 991-0905 |
| R3 | 5.6K Resistor, 1/4W | 991-0906 |
| R4 | 10K Resistor, 1/4W | 991-0877 |
| R5 | 1K Resistor, 1/4W | 991-0812 |
| R6 | 3.3K Resistor, 1/4W | 991-0921 |
| R7 | 2.7K Resistor, 1/4W | 991-0909 |
| R8 | 3.3K Resistor, 1/4W | 991-0921 |
| R9 | 3.3K Resistor, 1/4W | 991-0921 |
| R10 | 3.3K Resistor, 1/4W | 991-0921 |
| R11 | 10K Resistor, 1/4W | 991-0877 |
| R12 | 10K Resistor, 1/4W | 991-0877 |
| R13 | 10K Resistor, 1/4W | 991-0877 |
| R14 | 1.2K Resistor, 1/4W | 991-0920 |
| S1 | SPDT Slide Switch (Brown) | 996-0099 |
| S2 | 4 Position Slide Switch | 996-0096 |
| S3 | SPST Slide Switch | 996-0098 |
| S4 | SPDT Slide Switch (Brown) | 996-0099 |
| S5 | SPDT Slide Switch (Brown) | 996-0099 |
| S6 | SPDT Slide Switch (Brown) | 996-0099 |
| XZ1 | 28 Pin I.C. Socket | 994-0098 |
| Z1 | Integrated Circuit | 994-0487 |
| | Box, Antenna Switch | 993-0482 |
| | Cable, Antenna Switch Box, 10′ Coax | 997-0429 |
| | Cable, Control, LH | 997-0435 |
| | Cable, Control, RH | 997-0436 |
| | Printed Circuit Board, Modulator | 871-0749 |
| | Printed Circuit Board, TV Game | 871-0747 |
| | Wire, Buss | 997-0240 |
| | Wire, Prebonded, Stranded Conductor | 6000520 or 6000522 |
| | MECHANICAL | |
| | Bumper | 998-0416 |
| | Case, Battery | 997-0410 |
| | Case, Bottom, TV Game | 801-0289 |
| | Cover, Battery Compartment, TV Game | 801-0290 |
| | Handle, Bottom | 801-0293 |
| | Handle, Top, LH | 801-0292 |
| | Handle, Top, RH | 801-0291 |
| | Handle, Variable Resistor | 801-0295 |
| | Label, FCC | 890-1004 |
| | Screw, Thread Forming | 998-0436 |
| | Tie, Wire | 997-0421 |
| | Topper, Switch | 996-0097 |

Fig. 2-51. Parts list of the 60-3056 video game.

## TV SCOREBOARD MODEL 60-3057

This model of TV Scoreboard differs from the previous ones in that it is a four-player unit. Otherwise, the operation and specifications are similar to the models covered in previous pages. It operates on channels 3 and 4 with an RF output level that falls in the 1000 – 1500 μV range. The color and color subcarrier frequency is 3.5795 MHz, and the horizontal sync frequency is 15.734 kHz.

The 60-3057 can be powered by six 1.5V C-cells or by an AC adapter (RS 60-3053) rated at 9V DC, 140 mA. Normal current drain is 120–140 mA. The antenna switch box is constructed using a slide switch, a 75-to-300Ω balun, and filter. The balun matches the 75Ω output impedance of the video game to the 300Ω input impedance of the TV receiver. A diagram of the location of data pulses is shown in Fig. 2-52.

### BASIC OPERATION

A block diagram of the 60-3057 is shown in Fig. 2-53. Off-chip circuits involve the power supply, player controls, crystal oscillator, rifle/pistol stages, control board, sound amplifier, phase-shifting and gating stages, and RF modulator. Beyond the RF modulator is the antenna switch box.

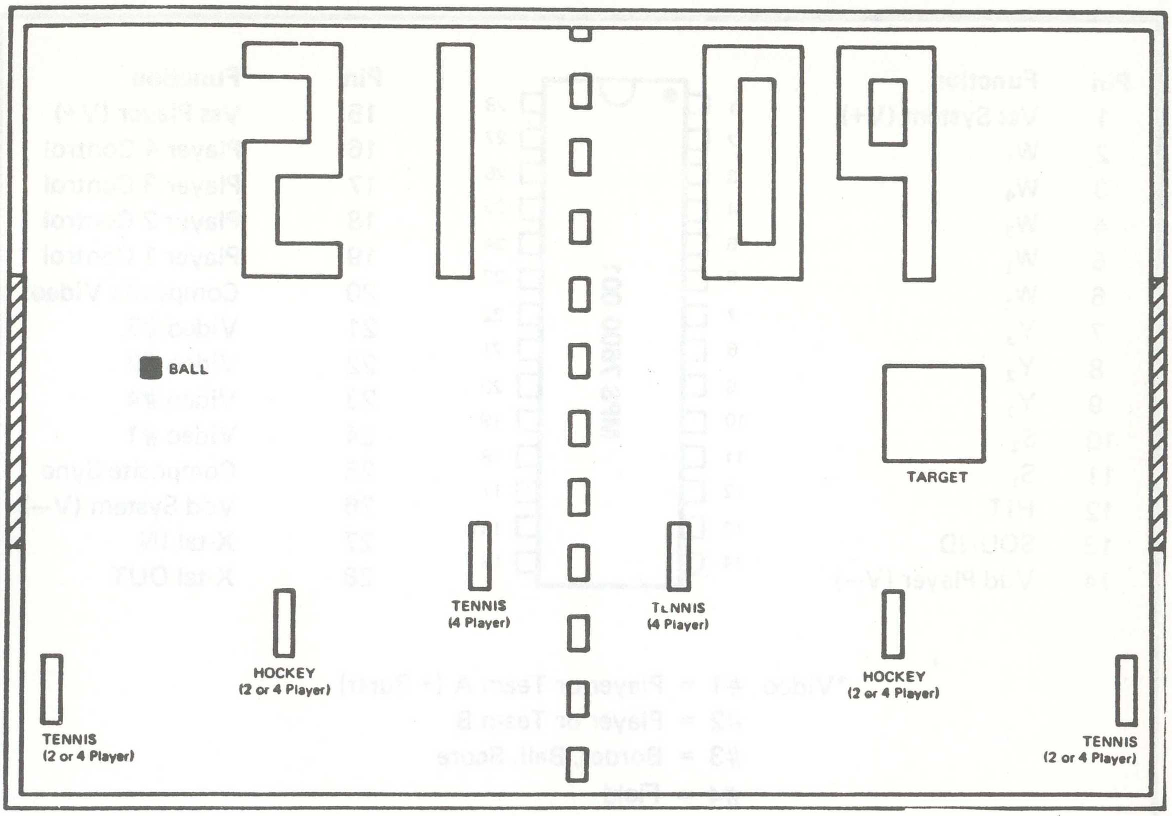



Fig. 2-52. Location of data pulses for the 60-3057 video game.

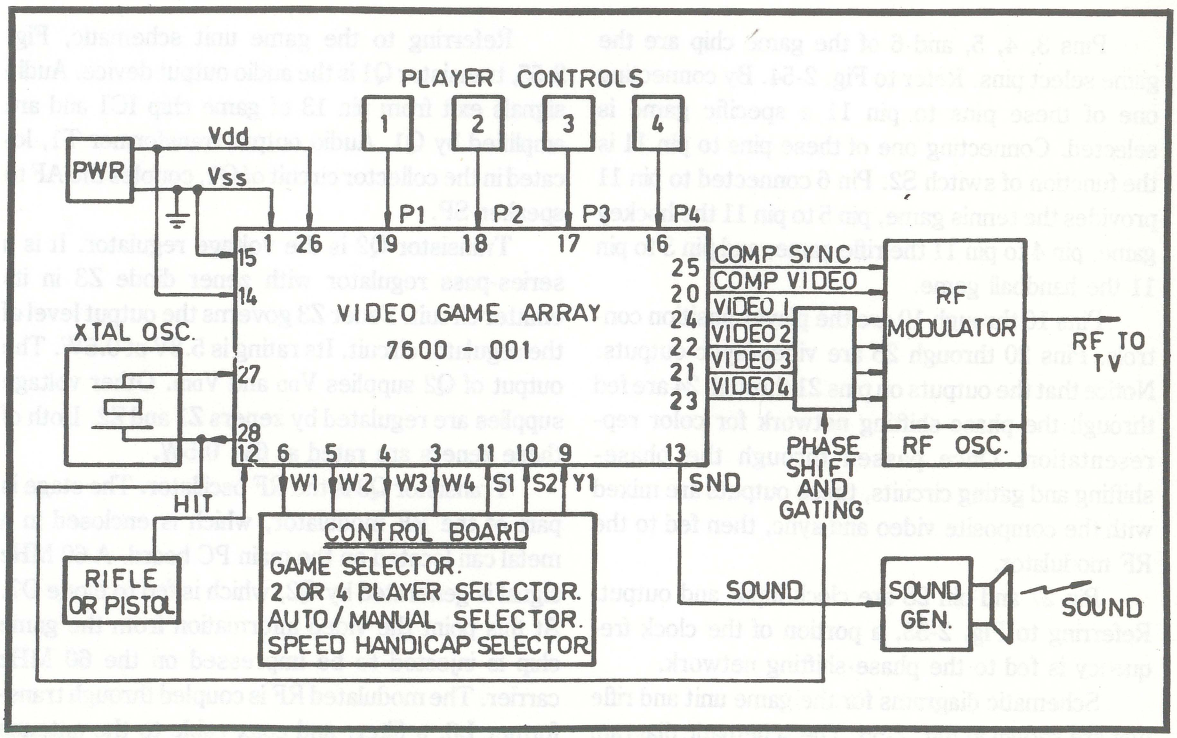
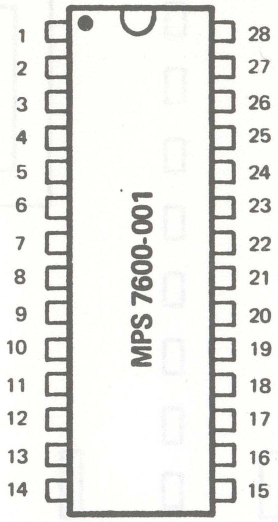



Fig. 2-53. Block diagram of the 60-3057 video game.

| Pin | Function | Pin | Function |
|---|---|---|---|
| 1 | Vss System (V+) | 15 | Vss Player (V+) |
| 2 | $W_5$ | 16 | Player 4 Control |
| 3 | $W_4$ | 17 | Player 3 Control |
| 4 | $W_3$ | 18 | Player 2 Control |
| 5 | $W_2$ | 19 | Player 1 Control |
| 6 | $W_1$ | 20 | Composite Video |
| 7 | $Y_3$ | 21 | Video #3 |
| 8 | $Y_2$ | 22 | Video #2 |
| 9 | $Y_1$ | 23 | Video #4 |
| 10 | $S_2$ | 24 | Video #1 |
| 11 | $S_1$ | 25 | Composite Sync |
| 12 | HIT | 26 | Vdd System (V−) |
| 13 | SOUND | 27 | X-tal IN |
| 14 | Vdd Player (V−) | 28 | X-tal OUT |




*Video #1 = Player or Team A (+ Burst)
#2 = Player or Team B
#3 = Border, Ball, Score
#4 = Field

Fig. 2-54. Pin connection diagram for the MPS7600-001 game chip used in the 60-3057 video game.

Pins 3, 4, 5, and 6 of the game chip are the game select pins. Refer to Fig. 2-54. By connecting one of these pins to pin 11 a specific game is selected. Connecting one of these pins to pin 11 is the function of switch S2. Pin 6 connected to pin 11 provides the tennis game, pin 5 to pin 11 the hockey game, pin 4 to pin 11 the rifle game, and pin 3 to pin 11 the handball game.

Pins 16 through 19 are the player position controls. Pins 20 through 25 are video/sync outputs. Notice that the outputs on pins 21 through 24 are fed through the phase-shifting network for color representation. Once passed through the phase-shifting and gating circuits, these outputs are mixed with the composite video and sync, then fed to the RF modulator.

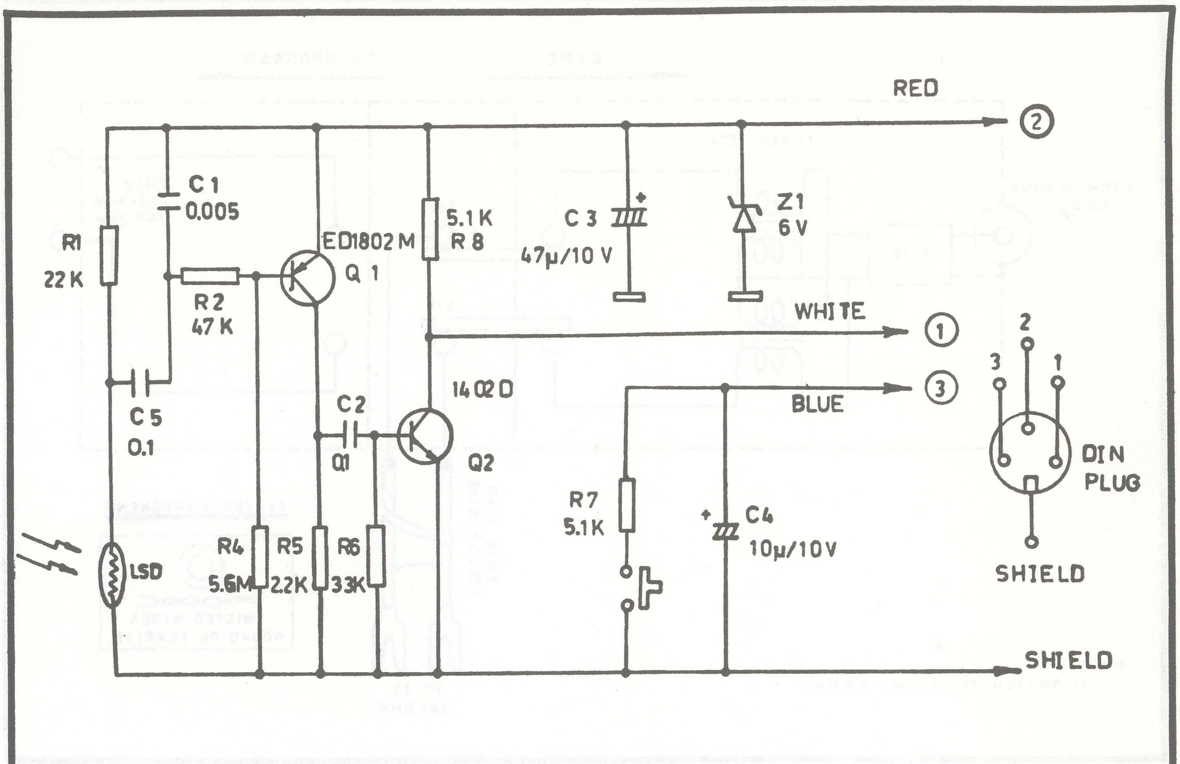
Pin 27 and pin 28 are clock input and output. Referring to Fig. 2-53, a portion of the clock frequency is fed to the phase-shifting network.

Schematic diagrams for the game unit and rifle unit are shown in Fig. 2-55. The schematic diagram for the antenna switch box is shown in Fig. 2-56.

Referring to the game unit schematic, Fig. 2-55, transistor Q1 is the audio output device. Audio signals exit from pin 13 of game chip IC1 and are amplified by Q1. Audio output transformer T1, located in the collector circuit of Q1, couples the AF to speaker SP.

Transistor Q2 is the voltage regulator. It is a series-pass regulator with zener diode Z3 in its emitter circuit. Zener Z3 governs the output level of the regulator circuit. Its rating is 5.8V at 0.5W. The output of Q2 supplies $V_{DD}$ and $V_{DD2}$. Other voltage supplies are regulated by zeners Z1 and Z2. Both of these zeners are rated at 6V, 0.5W.

Transistor Q3 is the RF oscillator. The stage is part of the RF modulator, which is enclosed in a metal can located on the main PC board. A 60 MHz signal is generated by Q2, which is fed to diode D7. At this point the video information from the game chip is injected to be impressed on the 60 MHz carrier. The modulated RF is coupled through transformer L6, a filter, and coax cable to the antenna switch box, where it is passed through a 75-to-300Ω



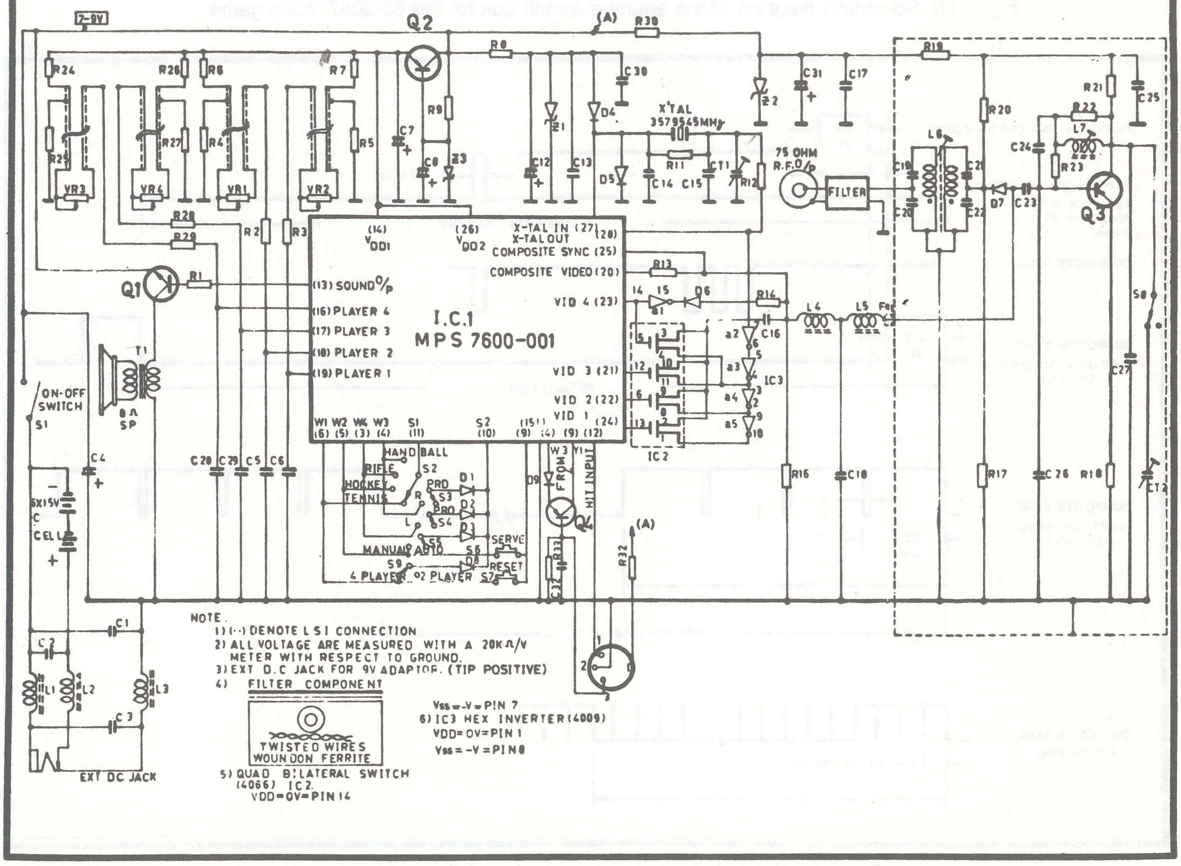




Fig. 2-55. Schematic diagram of the 60-3057 video game and rifle/pistol.

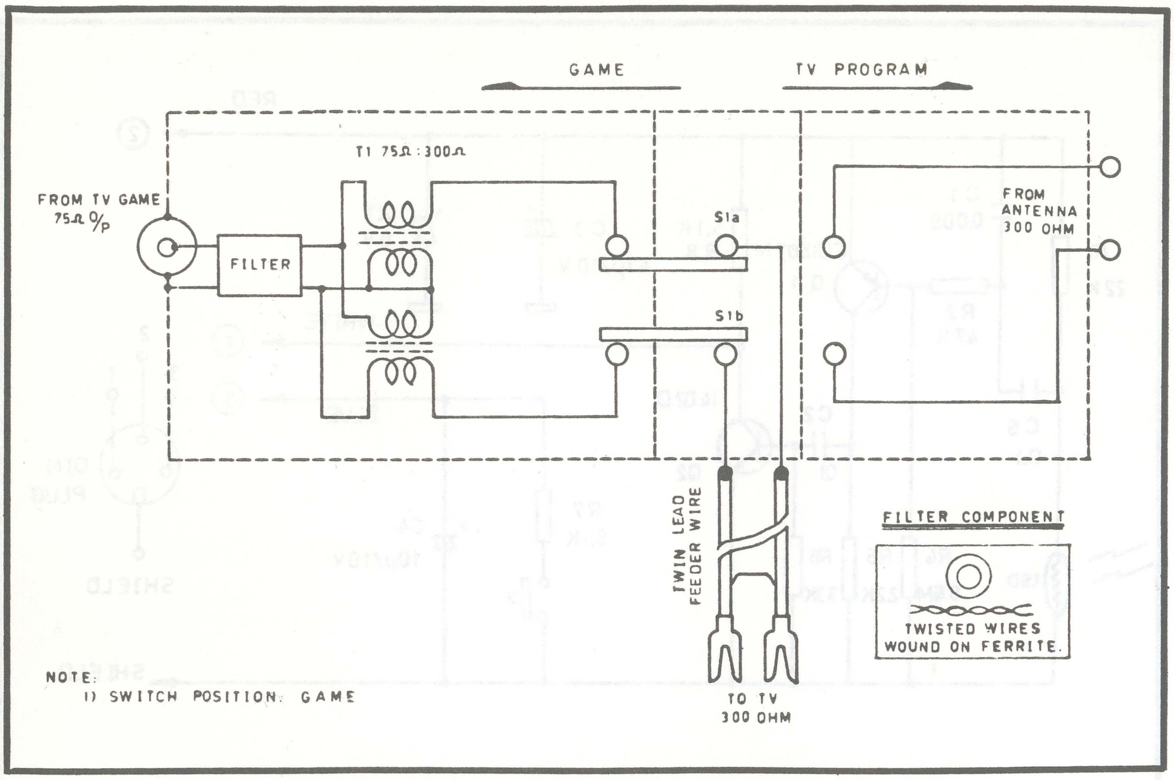



Fig. 2-56. Schematic diagram of the antenna switch box for the 60-3057 video game.

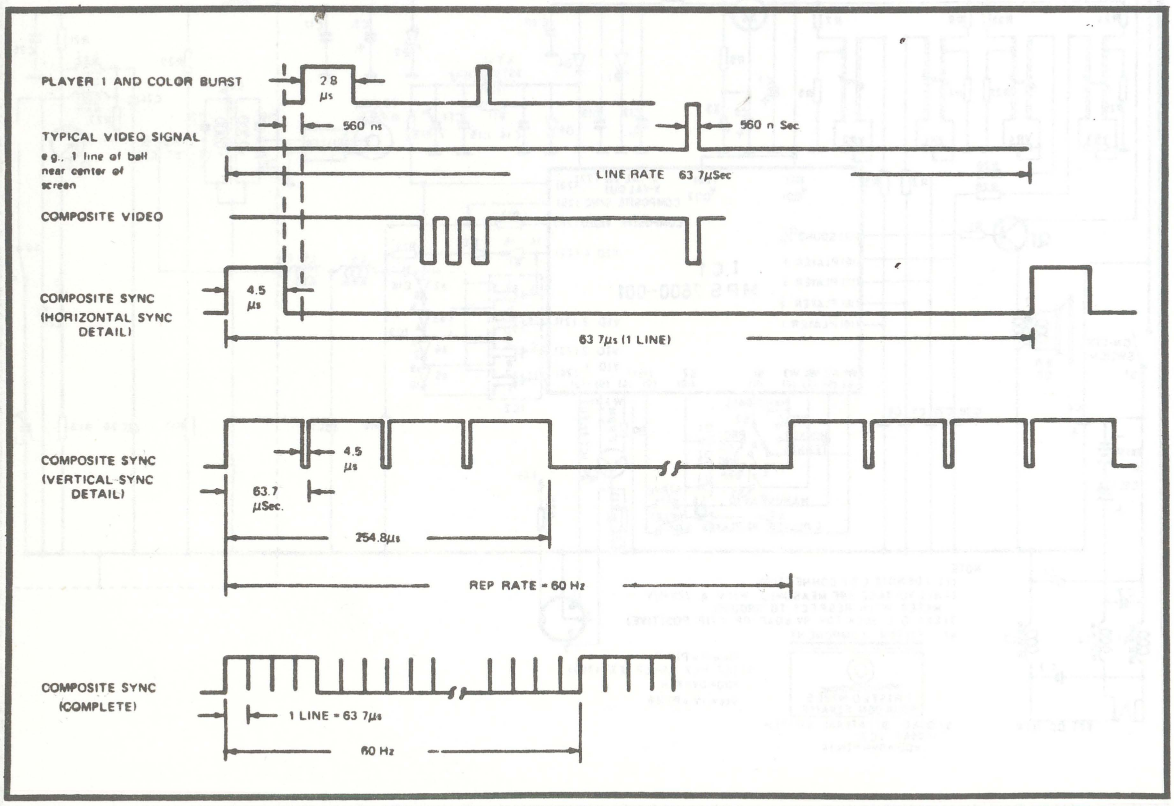



Fig. 2-57. Video timing waveforms in the 60-3057 video game.

balun for impedance matching. Then the RF is coupled to the antenna terminals of the TV receiver.

Transistor Q4 of the game board is the trigger switch for the rifle game. This transistor is controlled by the rifle trigger, located in the rifle circuit. Referring to the lower portion of Fig. 2-55, the rifle schematic, pin 3 of the DIN plug connects to the trigger switch. By closing the trigger switch, the microprocessor is informed that a shot has been fired. If the shot is on target, a hit is recorded at pin 1 of the DIN plug and fed to pin 12 of the microprocessor. To score a hit, light from the target on the TV screen must strike the light-sensitive device in the rifle. When this occurs, a pulse is set up and fed through transistors Q1 and Q2 in the rifle, which is coupled to pin 12 of the microprocessor.

The antenna switch box, shown in Fig. 2-56, is nothing more than a filer, slide switch, and balun. The balun matches the 75Ω output impedance of the video game to the 300Ω input impedance of the TV receiver. The switch is used to change the input of the TV from a game to a station signal.

Figure 2-57 is a diagram of video signals from the microprocessor. Studying them carefully will help understand the timing of basic signal outputs from the game chip.

## SERVICE ADJUSTMENTS

Do not perform any adjustments to the video game until you are sure that it is necessary. Take the time to carefully fine tune the TV receiver on channel 3 or channel 4.

During the following procedures, refer to Fig. 2-58 for the location of test points and adjustments outlined in the steps. Use nonmetallic tuning tools for all adjustments. Test equipment required to perform these procedures is as follows:

- 4-digit, 5 MHz frequency counter with 50 mV sensitivity.
- RF millivoltmeter (80 MHz with ±100 kHz accuracy).

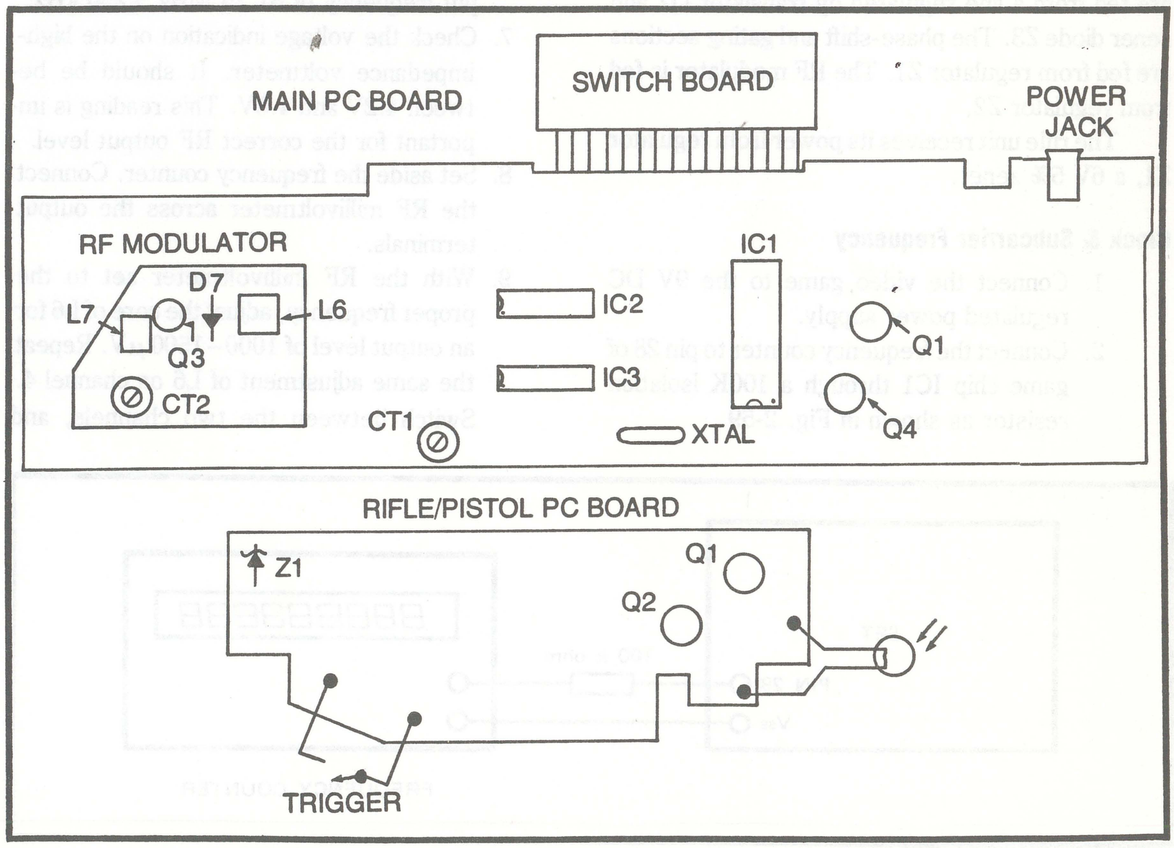



Fig. 2-58. PC board diagrams for the game unit and rifle/pistol in the 60-3057.

- High-impedance voltmeter.
- 9V DC regulated power supply (150 mA).
- Color TV receiver tunable on channels 3 and 4.
- Low-leakage soldering iron.

**CAUTION**

Almost all LSI chips are extremely susceptible to damage from static electricity or AC leakage. When working with units having MOS chips, use only a completely isolated soldering iron. Better yet, use a rechargeable battery-operated unit. In this manner, you will be assured that AC leakage will not damage the IC.

## Game Chip Replacement

If the game chip is defective, carefully remove it using desoldering tools, etc. When replacing the chip, be sure to position the pins properly with the dot next to pin 1. Do not handle the IC by its pins. Be sure power is off when making the replacement.

## Voltage Regulation

In the game unit there are basically three supply lines that are regulated. Supplies $V_{DD}$ and $V_{DD2}$ are fed from a line regulated by transistor Q2 and zener diode Z3. The phase-shift and gating sections are fed from regulator Z1. The RF modulator is fed from regulator Z2.

The rifle unit receives its power from regulator Z1, a 6V 5% zener.

## Clock & Subcarrier Frequency

1. Connect the video game to the 9V DC regulated power supply.
2. Connect the frequency counter to pin 28 of game chip IC1 through a 100K isolation resistor as shown in Fig. 2-59.
3. Adjust trimmer capacitor CT1 to give a frequency of 3.579545 MHz ±200 Hz. This frequency adjustment is critical for proper horizontal sync and color burst.

## Channel Frequencies

1. Connect the 9V DC regulated power supply to the video game.
2. Connect the high-impedance voltmeter to the junction of resistors R19 and R20. Set the meter to read positive DC volts in the 0–10V range. Connect the voltmeter's negative lead to chassis ground. Attach the leads from the frequency counter across the output terminals of the video game. Refer to Fig. 2-60 for the proper hookup.
3. Switch the video game to channel 4.
4. Adjust the core of coil L7 for an output frequency of 67.25 MHz ±250 kHz.
5. Switch the video game to channel 3.
6. Adjust trimmer capacitor CT2 for an output frequency of 61.25 MHz ±250 kHz.
7. Check the voltage indication on the high-impedance voltmeter. It should be between 4.2V and 4.5V. This reading is important for the correct RF output level.
8. Set aside the frequency counter. Connect the RF millivoltmeter across the output terminals.
9. With the RF millivoltmeter set to the proper frequency, adjust the core of L6 for an output level of 1000–1500 $\mu$V. Repeat the same adjustment of L6 on channel 4. Switch between the two channels, and

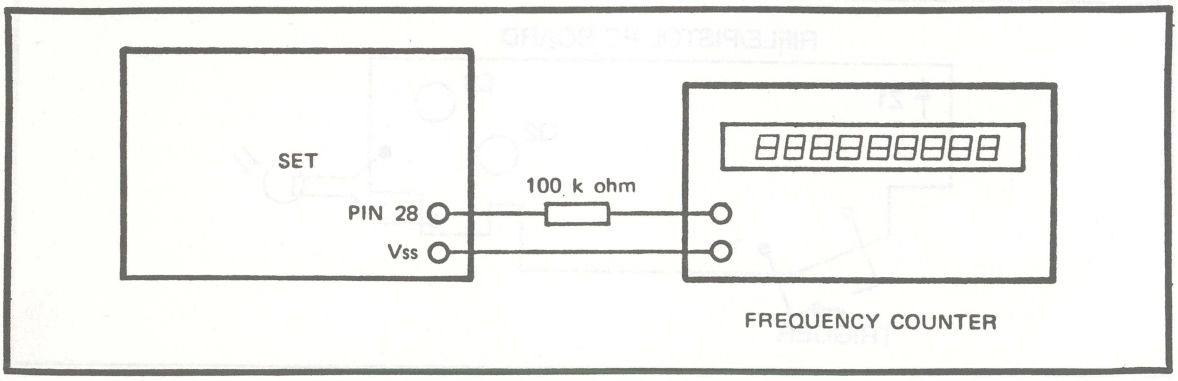



Fig. 2-59. Clock and subcarrier frequency adjustment setup.

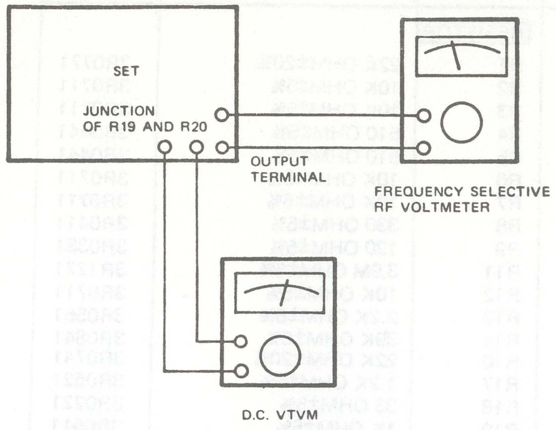



Fig. 2-60. Channel frequency test equipment setup.

balance the output levels so that they fall between the level specified above.

10. Remove all test equipment. Connect the video game to a color TV receiver to check the operation on channels 3 and 4.

## SYMPTOM/CAUSE INFORMATION

Listed below are several common symptoms accompanied with their probable causes. To use this information, first skim through the list of symptoms (boldface type) to locate the one that fits the problem at hand. If the exact symptom is not shown select one that comes close to your trouble; it may point you in the right direction so that you can localize the defect.

### No Sound

- Check speaker and its leads.
- Check transistor Q1 and its associated circuitry.

### No Clock & Color Subcarrier

- Defective game chip.
- No power supply voltage.
- Shorted zener diode Z3 or transistor Q2.

### No Voltage Regulation

- Defective zener diode Z3 or transistor Q2.
- Leaky capacitor C7, C8, or C12.

### Erratic Ball, Game, or Counting

- Low battery voltage.
- Check voltage regulator.

### Certain Games Do Not Work

- Defective game selector S2.
- Cold solder joint.
- Defective game chip IC1.

### No Color Display

- Defective voltage regulator Z1.
- Defective chip IC2 or IC3.

### No Hits With Target Game

- Defective transistor Q4.
- Broken wires to the rifle.
- Defective rifle DIN socket.

## REPLACEMENT PARTS

Whenever possible, replace defective parts with factory components. Common components, such as resistors, diodes, bipolar transistors, capacitor,e tc., can usually be safely replaced with parts purchased at your local electronics jobber. However, special items such as microprocessors, logic gates, transformers, and coils should be ordered from the manufacturer.

Replacement parts for the 60-3057 are shown in Figs. 2-61 through 2-64. Electronic parts for the game are shown in Fig. 2-61, while Fig. 2-62 covers electronic parts for the rifle. Mechanical parts for the game board and rifle are illustrated in Figs. 2-63 and 2-64.

| Ref. No. | Description | Mfr. No. |
|---|---|---|
| **CAPACITORS** | | |
| C1 | 0.005μF +80% −20% | 3C0624 |
| C2 | 0.005μF +80% −20% | 3C0624 |
| C3 | 0.005μF +80% −20% | 3C0624 |
| C4 | 470μF +100% −0 10V | 3E0171 |
| C5 | 0.047μF±10% 25V | 3C1140 |
| C6 | 0.047μF±10% 25V | 3C1140 |
| C7 | 47μF+100% −0 10V | 3E0131 |
| C8 | 47μF +100% −0 10V | 3E0131 |
| C12 | 47μF +100% −0 10V | 3E0131 |
| C13 | 0.1μF +80% −20% | 3C0684 |
| C14 | 5PF±0.5PF | 3C0040 |
| C15 | 47PF±5% | 3C0281 |
| C16 | 1.5PF±0.5PF | 3C0720 |
| C17 | 0.02μF +80% −20% | 3C9654 |
| C18 | 10PF±5% | 3C0111 |
| C19 | 25PF±5% | 3C0181 |
| C20 | 140PF±10% | 3C0420 |
| C21 | 30PF±5% | 3C0201 |
| C22 | 140PF±10% | 3C0420 |
| C23 | 6PF±0.5PF | 3C0050 |
| C24 | 0.001μF±20% | 3C0583 |
| C25 | 0.001μF±20% | 3C0583 |
| C26 | 100PF±10% | 3C0362 |
| C27 | 10PF±5% | 3C0111 |
| C28 | 0.047μF±10% 25V | 3C1140 |
| C29 | 0.047μF±10% 25V | 3C1140 |
| C30 | 0.04μF +80% −20% | 3C0664 |
| C31 | 47μF +100% −0 10V | 3E0131 |
| C32 | 0.04μF +80% −20% | 3C0664 |
| **DIODE** | | |
| D1 | IN4148 | 3M1051 |
| D2 | IN4148 | 3M1051 |
| D3 | IN4148 | 3M1051 |
| D4 | IN4148 | 3M1051 |
| D5 | IN4148 | 3M1051 |
| D6 | IN4148 | 3M1051 |
| D7 | IN4148 | 3M1051 |
| D8 | IN4148 | 3M1051 |
| D9 | IN4148 | 3M1051 |
| **COILS** | | |
| L1 | RF CHOKE 100μH 300MA | 2G1510 |
| L2 | RF CHOKE 100μH 300MA | 2G1510 |
| L3 | RF CHOKE 100μH 300MA | 2G1510 |
| L4 | RF CHOKE 90μH | 2G1520 |
| L5 | RF CHOKE 90μH | 2G1520 |
| L6 | DOUBLE TUNED COIL | 2T0680 |
| L7 | RF OSC COIL 0.43μH | 2T0670 |
| **TRANSISTOR** | | |
| Q1 | ED1702/PE8050B | 3M0331 |
| Q2 | 2SB405 | 3M0840 |
| Q3 | 9020G | 3M0304 |
| Q4 | PNP8550 | 3M0402 |

| Ref. No. | Description | Mfr. No. |
|---|---|---|
| **RESISTOR** | | |
| R1 | 22K OHM±20% | 3R0771 |
| R2 | 10K OHM±5% | 3R0711 |
| R3 | 10K OHM±5% | 3R0711 |
| R4 | 510 OHM±5% | 3R0441 |
| R5 | 510 OHM±5% | 3R0441 |
| R6 | 10K OHM±5% | 3R0711 |
| R7 | 10K OHM±5% | 3R0711 |
| R8 | 330 OHM±5% | 3R0411 |
| R9 | 120 OHM±5% | 3R0331 |
| R11 | 3.9M OHM±5% | 3R1221 |
| R12 | 10K OHM±5% | 3R0711 |
| R13 | 2.2K OHM±5% | 3R0561 |
| R14 | 39K OHM±5% | 3R0841 |
| R16 | 22K OHM±20% | 3R0741 |
| R17 | 1.2K OHM±5% | 3R0521 |
| R18 | 33 OHM±5% | 3R0221 |
| R19 | 1K OHM±5% | 3R0511 |
| R20 | 3.9K OHM±5% | 3R0621 |
| R21 | 15K OHM±20% | 3R0741 |
| R22 | 22K OHM±20% | 3R0771 |
| R23 | 150K OHM±20% | 3R0971 |
| R24 | 10K OHM±5% | 3R0711 |
| R25 | 510 OHM±5% | 3R0441 |
| R26 | 10K OHM±5% | 3R0711 |
| R27 | 510 OHM±5% | 3R0441 |
| R28 | 10K OHM±5% | 3R0711 |
| R29 | 10K OHM±5% | 3R0711 |
| R30 | 560 OHM±5% | 3R0451 |
| R32 | 1K OHM±5% | 3R0511 |
| R33 | 10K OHM±5% | 3R0711 |
| **ZENER DIODE** | | |
| Z1 | Zener Diode 6V±5% @1MA½W | 3M123 |
| Z2 | Zener Diode 6V±5% @1MA½W | 3M123 |
| Z3 | Zener Diode 5.8V±5% @1MA400mW | 3M254 |
| **L.S.I. AND CRYSTAL** | | |
| IC1 | L.S.I. MCS7600-001(MOS) | 1V1730 |
| IC2 | L.S.I. 4066 | 1V1700 |
| IC3 | L.S.I. 4009 | 1V1710 |
| | Crystal 3.579545MHZ | 3K0020 |
| **OTHER ELECTRICAL PARTS** | | |
| S8 | Slide switch 1P2T | 2S0040 |
| CT1 | Trimmer 20PF | 3E1020 |
| CT2 | Trimmer 10PF | 3E1010 |
| | I.C. Socket | 2J0010 |
| | Output transformer | 2T1380 |
| | 5 Pin Din Socket & | 2J0030 |
| | Plug | 2J0040 |
| VR1 | 1M OHM±20% linear type | 2R0221 |
| VR2 | 1M OHM±20% linear type | 2R0221 |
| VR3 | 1M OHM±20% linear type | 2R0221 |
| VR4 | 1M OHM±20% linear type | 2R0221 |
| | Speaker 8 OHM 2¼" | 2L0021 |
| | Heatsink | 5M0500 |
| | 2.5 Earphone Jack | 3J0251 |
| | Double Wire with Wrap | 3W1441 |
| | 75 OHM Coaxial Cabel | 3W1421 |
| | MAIN P. C. BOARD | IP3120 |
| | SWITCH P. C. BOARD | IP1850 |
| **FERRITE BEAD** | | |
| Fe1 | Ferrite Bead 5x3.5MM | 2B0520 |

Fig. 2-61. Electrical parts list of the 60-3057 (1 of 2).

| Ref. No. | Description | Mfr. No. | Ref. No. | Description | Mfr. No. |
|---|---|---|---|---|---|
| CAPACITORS | | | RESISTOR | | |
| C1 | 0.005μF | 3C0624 | R1 | 22K OHM | 3R0771 |
| C2 | 0.1μF | 3C0684 | R2 | 47K OHM | 3R0861 |
| C3 | 47μ/10V | 3E0131 | R4 | 5.6M | 3R1241 |
| C4 | 10μ/10V | 3E0091 | R5 | 2.2K | 3R0561 |
| C5 | 0.1μF | 3C0684 | R6 | 33K OHM | 3R0821 |
| DIODE | | | R7 | 5.1K OHM | 3R0661 |
| D1 | Zener 6.2V +5% −0% | 3M124 | R8 | 5.1K OHM | 3R0661 |
| | | | OTHER PARTS | | |
| TRANSISTOR | | | | MAIN P. C. BOARD | IP3540 |
| Q1 | ED1802M | 3M0383 | | | |
| Q2 | ED1402D | 3M0174 | | | |

Fig. 2-62. Electrical parts list of the 60-3057 (2 of 2).

| Ref. No. | Description | Mfr. No. | Ref. No. | Description | Mfr. No. |
|---|---|---|---|---|---|
| | Front Cabinet | 4A8066 | | Keybutton Tip | 4A2300 |
| | Back Cabinet | 4A9900 | | Push Button Knob | 4A8411 |
| | Battery Door | 4A8080 | | Eyelet | 6W0580 |
| | Control Box Top | 4A9490 | | Contact Spring | 4T2090 |
| | Control Box Bottom | 4A9500 | | Soldering Terminal | 4T2100 |
| | Slide Control Knob | 4A0830 | | Control Panel Plate | 7P511 |
| | Mounting Bracket | 4B0460 | | Score Knob Cap Plate | 7P508 |
| | Battery Connecting Terminal | 4T0780 | | Push Button Knob Plate | 7P509 |
| | Battery Positive Plate | 4T0800 | | Aluminium Sleeve | 4T2050 |
| | Battery Negative Spring | 4T0790 | | Score Board | 1P2800 |
| | Press Pin | 4T0840 | | Keyboard P.C.B. | 1P1850 |
| | Tin Foil Paper | 0C0030 | | Screw T2x6CR-P/H | 6S1541 |
| | Shield Can | 4T0770 | | Coil Spring | 4T0970 |
| | Shield Can Cover | 4T0762 | | Coil Spring | 4T1000 |
| | Bottom Shield | 4T1630 | | Ball | 4T1010 |
| | R.F. Bottom Shield | 4T1510 | | Switch Contact | 4T1290 |
| | Insulator | 4F0230 | | Switch Contact | 4T1281 |
| | Cord Cover | 4F0260 | | Disc | 4J0010 |
| | Speaker Screen | 4F0210 | | Disc Retainer Mylar | 4K0850 |
| | Battery Sponge | 6G0330 | | Cover Mylar | 4K0860 |
| | Rubber Stand | 4A0860 | | Slide Switch Felt | 4F0310 |
| | Cable Clip | 4B0190 | | Screw ST2.6x6CR-P/H | 6S1521 |
| | Felt, Slide Control | 4F0220 | | Screw ST2.6x8CR-P/H | 6S1551 |
| | Rubber Sheet | 6G1470 | | Screw ST2.6x8CR-P/H (Black Oxide) | 6S1556 |
| | Pad Cork | 6G0620 | | Screw ST3.0x6CR-P/H | 6S1581 |
| | Bottom Shield | 4T2130 | | Screw ST3.0x8CR-P/H (Black Oxide) | 6S1566 |
| | Insulator | 4F0450 | | Screw ST3.0x10CR-P/H | 6S1571 |
| | Jack Panel Plate | 7P517 | | Screw ST3.0x8CR-P/H | 6S1561 |
| | Rifle Panel Plate | 7P510 | | Screw M2.6xP0.45x6CR-K/H | 6S1662 |
| | Keyboard Assembly | 4X1040 | | Screw M3.0xP0.6x10CR-P/H (Black Oxide) | 6S1460 |
| | Ant Box Assembly | 4X1140 | | Screw M3.0xP0.5X5CR-R/H | 6S1370 |
| | Rifle Assembly | 4X1301 | | Screw M3xP0.6x8CR-P/H | 6S1226 |
| | Main P.C.B. | 1P1850 | | Nut M2.6xP0.45x1.5T | 6N0020 |
| | Eyelet | 6W0290 | | Washer, Internal Teeth | 6W0370 |
| | Brass Insert | 5D0801 | | Washer, Metal | 6W0140 |
| | Brass Insert | 5D0870 | | Metal Washer | 6W0590 |
| | Brass Washer | 6W0570 | | Connecting Terminal | 4T1650 |
| | Control Panel | 4A8403 | | Back Label | 7J233 |
| | Score Knob Cap | 4A8351 | | Name Plate | 7P507 |
| | Score Knob | 4A8150 | | | |
| | Switch Knob | 4A8421 | | | |
| | Game Selecting Knob | 4A8360 | | | |

Fig. 2-63. Mechanical parts list for the game unit of the 60-3057.

| Ref. No | Description | Mfr. No. | Ref. No. | Description | Mfr. No. |
|---|---|---|---|---|---|
| PLASTIC PARTS: | | | METAL PARTS: | | |
| | Store-Left | 4B0600 | | Brass Insert | 5D1030 |
| | Store-Right | 4B0610 | | Screw$\phi$3x10CR-RH B/O | 6S0095 |
| | Pistol-Left | 4B0620 | | Screw M4x0.7Px250/H B/O | 6S1888 |
| | Pistol-Right | 4B0630 | | Screw M4x0.7Px30 O/H B/O | 6S1898 |
| | Fore Grip-Left | 4B0640 | | Screw M2.6x0.45Px10R/H B/O | 6S1170 |
| | Fore Grip-Right | 4B0650 | | Nut W/M2.6x0.45P B/O | 6N0025 |
| | Trigger | 7A050 | | Nut W/M4x0.7Px4 B/O | 6N0070 |
| | Scope Shaped Sight | 4B0660 | | Screw M4x0.7px250/H B/O | 6S1888 |
| | Scope Shaped Sight | 4B1040 | | Screw M3x0.5Px10R/H B/O | 6S1955 |
| | Fore Nut | 4B0700 | | Nut W/M3x0.5Px3THK B/O | 6N0060 |
| | Convex Lens | 7L053 | | Screw M3x0.5Px28R/H B/O | 6S2005 |
| | Focus Tube | 4B0680 | | Screw M3x0.5Px18R-H B/O | 6S2015 |
| | Fixer W/M5x0.8Px38 | 4B0670 | MISCELLANEOUS PARTS: | | |
| | Long-Barrel | 4B0690 | | Photo Darlington PT410 | 3M416 |
| | Short-Barrel | 4B1050 | | 3 Wires Shield Cable | 2J0110 |
| | Switch Housing | 4A9930 | | Saymakalo #48 Polyester Tape | 4K0960 |
| | Switch Knob | 4A9550 | | P.C.B. Photo Darlington $\phi$21.5 | 1P3360 |
| | Key Button Tip | 4A2300 | | Switch P.C. Board | 1P3210 |
| | | | | Pad Cork 20x7x9 | 6G0560 |
| METAL PARTS: | | | | Double Side Tape ½" | 6G0600 |
| | | | | 1/8" Pad Cork | 6G0630 |
| | Square Nut | 6N0080 | | | |
| | Coil Spring | 4T0970 | | | |
| | Disc | 4J0011 | | | |
| | Screw-Male Insert | 6S1900 | | | |

**Fig. 2-64. Mechanical parts list for the rifle/pistol of the 60-3057.**

# CHAPTER 3

# MAGNAVOX ODYSSEY TV VIDEO GAMES

Odyssey is a game simulator capable of duplicating the playing field and actions of three separate games. These are smash, tennis, and hockey. In the smash (handball) mode, a solid vertical bar or wall is displayed on the left side of the screen. Two players are positioned on the right side. The ball will bounce off invisible top and bottom rebound lines and the left wall. The object of the game is to hit the ball against the left wall or the top or bottom rebound lines and make your opponent miss the ball when it rebounds back to the right. A player scores a point when his opponent fails to hit the ball before it goes off the right side of the screen.

All three games use an english control. Circuitry inside the game decides which player will have english control and this alternates as the ball is hit. When player number one touches the ball, his english control is activated and he can move the ball vertically. As soon as his opponent hits the ball, player number one loses english control and player number two can move the ball vertically.

In the tennis mode, a solid vertical line runs down the middle of the screen to simulate a net. Two or four on-screen players may be used. The back court player has no individual controls and moves only vertically while following the front player. The front player can be moved horizontally as well as vertically. The ball will rebound off invisible top and bottom rebound lines. The object of this game, as in real tennis, is to get the ball past the opposing player.

Hockey may also be a two- or four-player game. Right and left vertical walls are displayed with blank spaces (goals) in the center of each wall. The object of this game is to get the ball through the opening in the opponent's wall.

All games use on-screen bar scoring. These are two short vertical bars displayed in the lower-left portion of the screen. When a player scores, his bar moves one step to the right until one of the players gets 15 points. At a score of 15, the scorekeeper resets itself to zero.

When a player hits the ball, or the ball reverses horizontal direction, a beep is produced by a ceramic transducer. The game connects to the VHF terminals of any TV set through a game/TV select switch. The unit is battery powered and may be used with an optional 9V AC adapter.

## ODYSSEY MODELS YF7010 & YF7015

The six ICs that make up the heart of the game and their basic functions are shown in Fig. 3-1. Each video generator contributes part of the display, depending on which game is selected. The logic control, located in IC5, tells each IC what is needed for a particular game. The game select switch sets up the game to be played.

Although the heavy arrows in Fig. 3-1 go directly from the ICs to the screen, in actual operation, all video generators send their video signals to

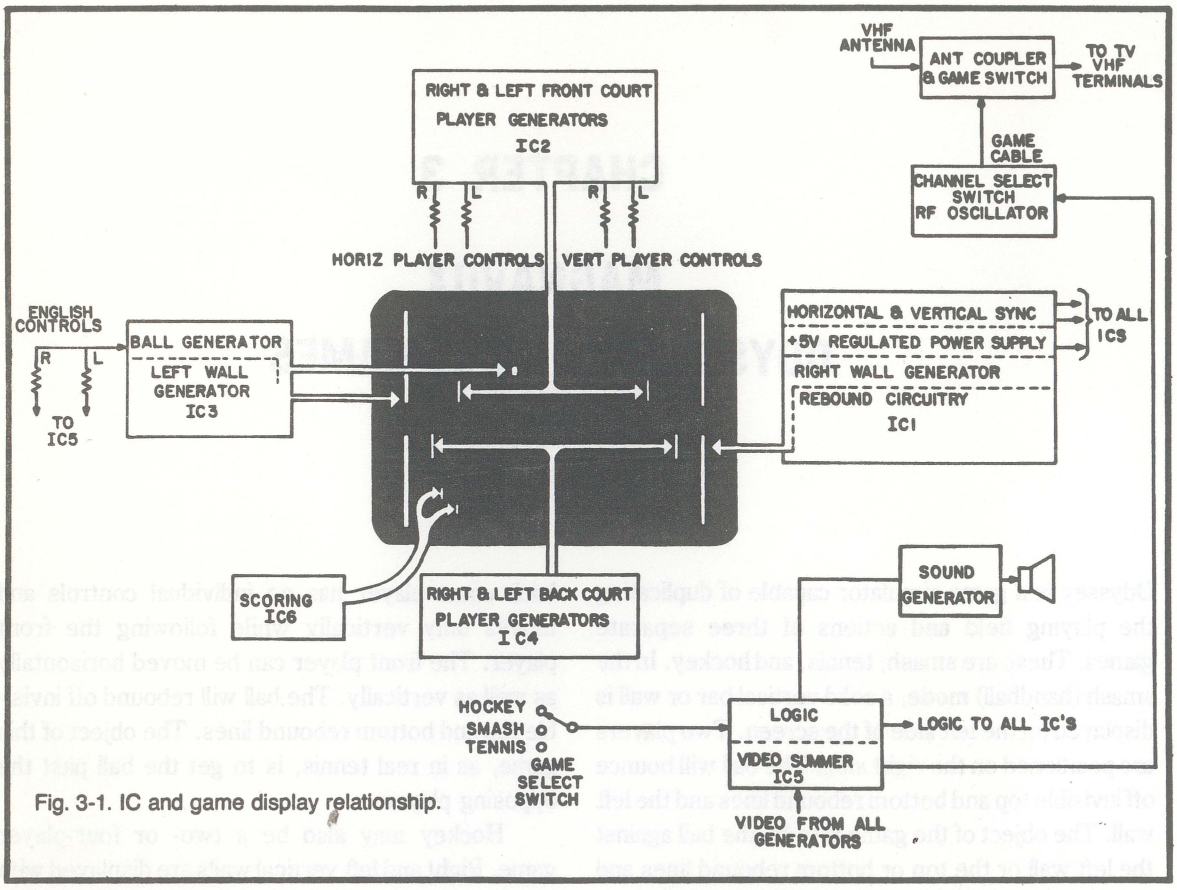



Fig. 3-1. IC and game display relationship.

the video "summer" in IC5. The video summer combines all the signals into one video signal and sends it to the RF section, where it modulates the carrier that is coupled through the antenna coupler to the TV set.

The block diagram in Fig. 3-2 shows the interconnections between the ICs and the controls associated with the video generators. IC1 contains the 5V regulated power supply, the vertical and horizontal sync generators, the right wall generator, and the rebound circuitry. IC2 contains the right and left frontcourt player generators with controls to move the players vertically and horizontally. IC3 has the left wall generator with a horizontal position control and the ball generator with a speed control. The ball-rebound logic from IC1 and ball-vertical-control voltage from IC5 (via the english controls) are coupled into the ball generator. IC4 is the right and left backcourt player generator. It uses the same vertical controls as IC2 but has no horizontal controls. The video summer and the game logic are contained in IC5. IC6 contains the counters and memory for the on-screen scoring. The sound generator and the RF oscillator are discrete transistor circuits.

An RF circuit provides a modulated output on either VHF channel 3 or 4. The output is coupled through a cable to an antenna coupler that connects to the TV set's VHF terminals. The VHF antenna is also connected to the coupler, and a switch is provided so the game may be played without having to disconnect the antenna. For game specifications refer to the chart in Fig. 3-3.

## SERVICE ADJUSTMENTS

Refer to Fig. 3-4 for the location of the following adjustments.

### Horizontal Frequency

1. Connect a frequency counter to pin 16 of IC1.
2. Adjust horizontal frequency control R2 for 15,734 Hz ± 30 Hz.

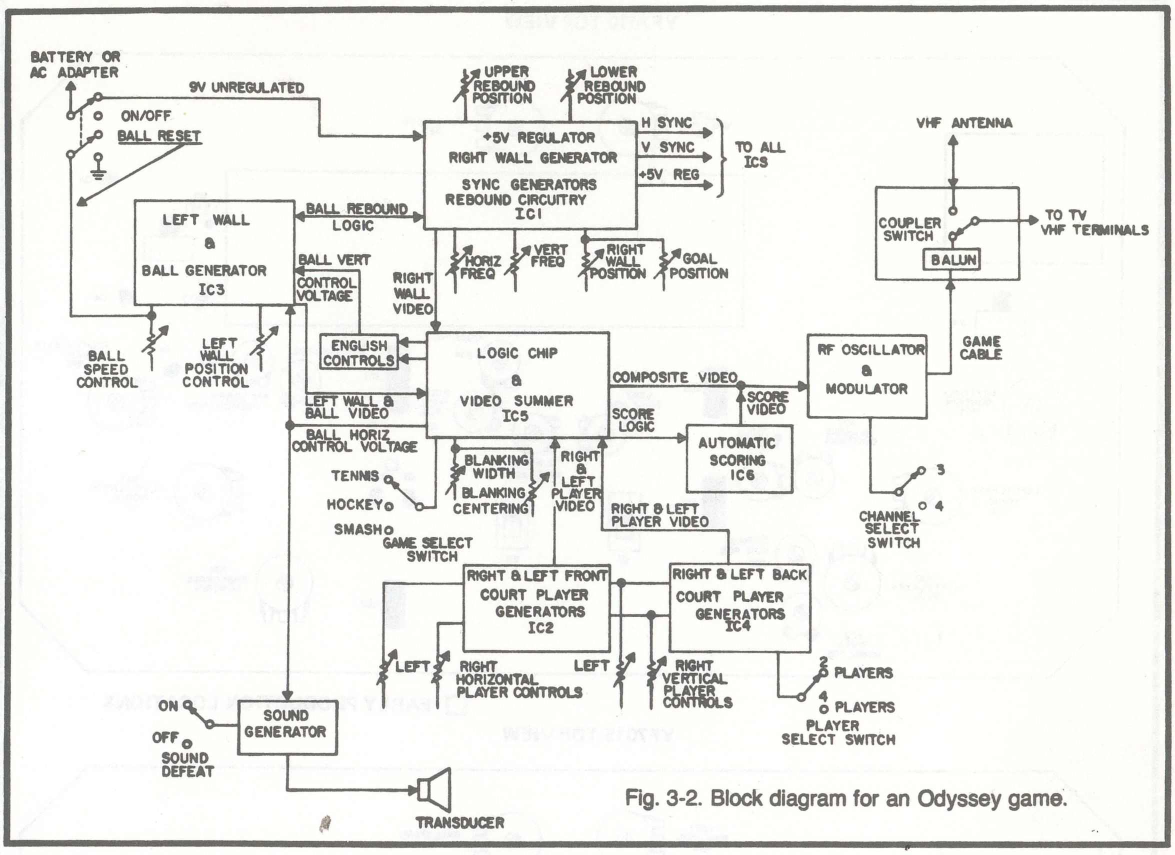



Fig. 3-2. Block diagram for an Odyssey game.

| | Minimum | Nominal | Maximum |
|---|---|---|---|
| **Regulated Voltage Supply** | | | |
| Measured at Pin 3 of IC1 | 4.5V | 5.0V | 5.5V |
| **Current Drain** | | | |
| YF7010 | ----- | 45 Ma | ----- |
| YF7015 | ----- | 65 Ma | ----- |
| **Vertical Sync** | | | |
| Frequency | 59 Hz | 60 Hz | 61 Hz |
| Pulse Amplitude | 3.5V | ----- | ----- |
| Pulse Width | 180 usec | 210 usec | 250 usec |
| **Horizontal Sync** | | | |
| Frequency | 15.704 KHz | 15.734 KHz | 15.784 KHz |
| Pulse Amplitude | 3.5V | ----- | ----- |
| Pulse Width | 4.0 usec | ----- | 7.0 usec |
| **RF Carrier Frequency** | | | |
| Channel 3 | 61.22 MHz | 61.25 MHz | 61.28 MHz |
| Channel 4 | 67.22 MHz | 67.25 MHz | 67.28 MHz |
| **RF Output** | | | |
| Into 300 ohms | 1100 uv | ----- | 1600 uv |

Fig. 3-3. Game specifications chart.

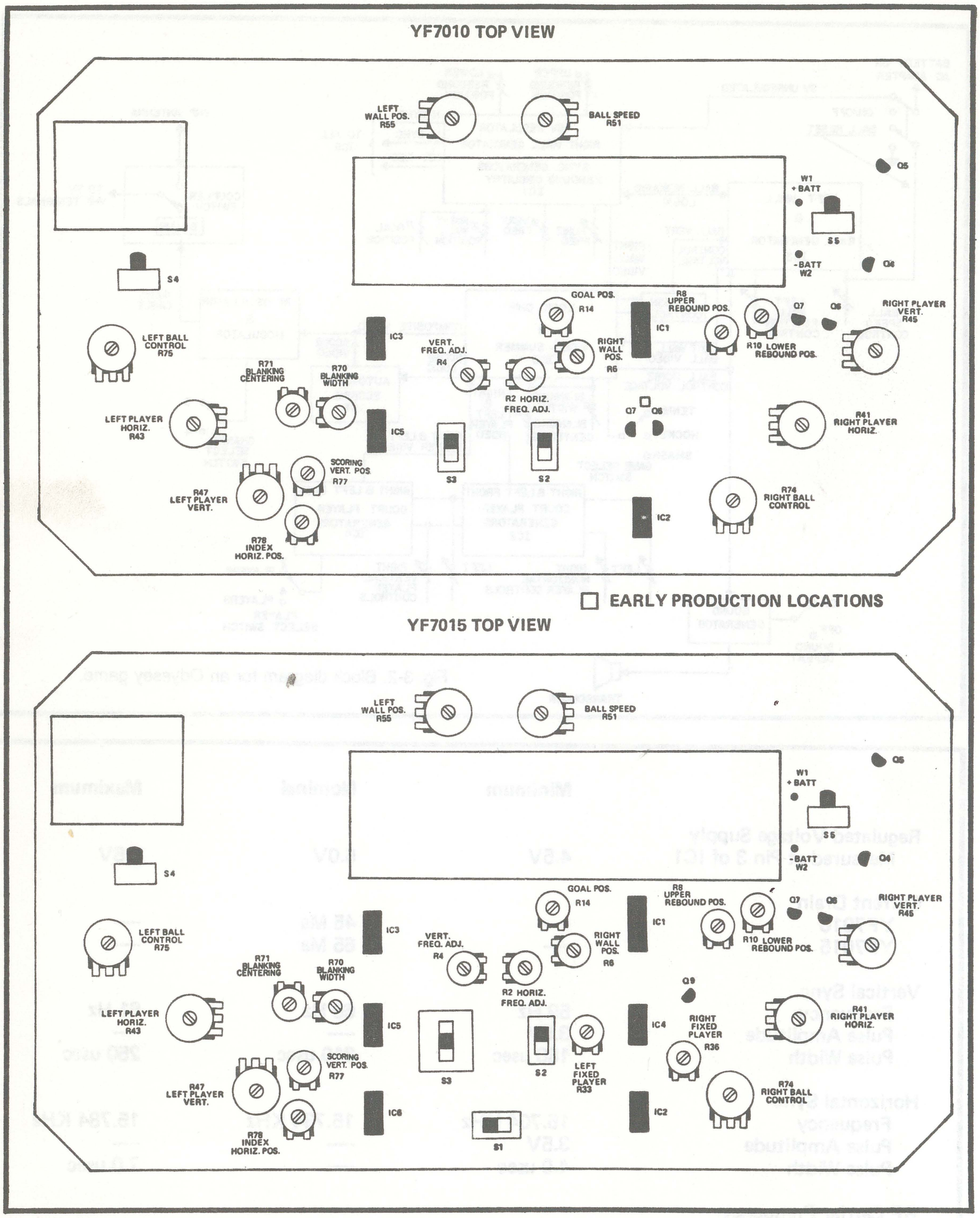



Fig. 3-4. Adjustment control locations.

**Vertical Frequency**

1. Connect a frequency counter to pin 14 of IC1.
2. Adjust vertical frequency control R4 for 60 Hz ± 1 Hz.

**Blanking Width & Centering**

1. Connect a scope to the composite video output at pin 5 of IC5.
2. Apply +3V DC bias to pin 8 of IC5.

3. Adjust blanking width control R70 for a 16 ms width.
4. Adjust blanking centering control R71 for 6 ms before the horizontal sync pulse.

### Top & Bottom Rebound

1. Connect +3V DC bias to pin 3 of IC3.
2. Rotate right ball control R74 to its maximum counterclockwise position and left ball control R75 to its clockwise position. Only one control will have any effect.
3. Adjust lower rebound control R10 until the entire ball is visible at the bottom of the screen.
4. Turn right ball control R74 to its maximum clockwise position and left ball control R75 to its maximum counterclockwise position.
5. Adjust upper rebound control R9 until the entire ball is visible at the top of the screen.

NOTE

Place the game switch to C (hockey) and the players switch to 4 for the following adjustments.

### Right Wall Horizontal Position

Adjust right wall horizontal control R6 until the right wall is as close as possible to the right side of the screen and still fully visible.

### Goal Opening Position

Adjust goal opening control R14 until the goal openings in both walls are centered vertically.

### Score Indicator Position

1. Adjust horizontal score control R78 until the indicators are 1 inch to the right of the left hockey wall.
2. Adjust vertical score control R77 until the lowest part of the score indicator is about 1 inch from the bottom of the screen.

### Right & Left Fixed Player

1. Adjust left fixed player horizontal control R33 until the player is displaced by approximately its width to the right of the left wall.
2. Adjust right fixed player horizontal control R36 until the player is displaced by approximately its width to the left of the left wall.

Voltage charts and IC basic functions are shown in Fig. 3-5. The main PC board diagram for the YF7010 is shown in Fig. 3-6, while the PC board for the YF7015 is in Fig. 3-7. A schematic diagram of the YF7010 is located in Fig. 3-8. The schematic diagram for the YF7015 is illustrated in Fig. 3-9. A parts list for both units is shown in Fig. 3-10.

## SYMPTOM/CAUSE INFORMATION TROUBLESHOOTING GUIDE

This troubleshooting guide is for the YF7010 and YF7015 Odyssey video games. Symptoms are followed by the most probable causes and the easiest methods for locating the exact trouble.

With the Odyssey connected to the TV set and both are on the same channel, set the switch on the unit to the game position. Check the voltage at the battery terminals with the on-off switch in the on position. If the batteries read less than 7.0V, replace them. A milliammeter, in series with the power supply, should indicate 45 mA or less for the YF7010 and 65 mA or less for the YF7015.

### Snow on the TV Screen

- Check for proper attachment of the switch box to the TV set.
- Check for a faulty or poorly connected RF game cable.
- Make sure antenna-game switch is in the game position.
- Check for defective antenna-game switch box.
- Turn on the sound switch and the main power on-off switch. Rotate the right player horizontal control to both extremes. Rotate the left player horizontal control to both extremes.
  1. *Beeping sound.* Troubleshoot the RF section. Check for defective components, short, or open.
  2. *No sound.* Check for a defect in the power supply, including continuity through on-off switch, AC jack, battery terminal wires, and PC board foil.

## YF7010 & YF7015 VOLTAGE CHARTS

**IC1**

| PIN | VOLTAGE | NOTE |
|---|---|---|
| 1 | 0V | ----- |
| 2 | 4.4V | ----- |
| 3 | 5.2V | ----- |
| 4 | 0V | ----- |
| 5 | 2.7V | ----- |
| 6 | .9V to 1.3V | 4 |
| 7 | 2.1V to 2.7V | 5 |
| 8 | 0V | ----- |
| 9 | .08V | ----- |
| 10 | 4.7V | ----- |
| 11 | 1V | ----- |
| 12 | 2.4V | ----- |
| 13 | 2V to 4.5V | 7 |
| 14 | .10V | ----- |
| 15 | 5.2V | ----- |
| 16 | .40V | ----- |
| 17 | 3.0V | ----- |
| 18 | 2.1V | ----- |

**IC2**

| PIN | VOLTAGE | NOTE |
|---|---|---|
| 1 | .4V | ----- |
| 2 | 5.2V | ----- |
| 3 | 1.7V to 3.1V | 8 |
| 4 | 2.0V | ----- |
| 5 | 1V to 4.5V | 10 |
| 6 | 0V | ----- |
| 7 | 1.3V | ----- |
| 8 | .07V | ----- |
| 9 | .08V | ----- |
| 10 | 1.3V | ----- |
| 11 | 0V | ----- |
| 12 | 1V to 4.5V | 11 |
| 13 | .9V | ----- |
| 14 | 1.7V to 3.1V | 9 |
| 15 | 0V | ----- |
| 16 | .15V | ----- |

**IC3**

| PIN | VOLTAGE | NOTE |
|---|---|---|
| 1 | .4V | ----- |
| 2 | 5.2V | ----- |
| 3 | 2.2V to 2.9V | 1 |
| 4 | .9V to 1.7V | 1 |
| 5 | 1.7V to 3.7V | 2 |
| 6 | 0V | ----- |
| 7 | 1.4V | ----- |
| 8 | 0V | ----- |
| 9 | .15V | ----- |
| 10 | 4.7V | ----- |
| 11 | 5.2V | ----- |
| 12 | 1.1V to 3.5V | 6 |
| 13 | 1.4V | ----- |
| 14 | 1.9V to 3.3V | 3 |
| 15 | 0V | ----- |
| 16 | .15V | ----- |

**IC4**

| PIN | VOLTAGE | NOTE |
|---|---|---|
| 1 | .4V | ----- |
| 2 | 5.2V | ----- |
| 3 | 2.1V to 3.8V | 12 |
| 4 | 2.2V | ----- |
| 5 | 1V to 4.5V | 10 |
| 6 | 0V | ----- |
| 7 | 1.4V | ----- |
| 8 | .07V | ----- |
| 9 | .08V | ----- |
| 10 | 1.1V | ----- |
| 11 | .2V | ----- |
| 12 | 1V to 4.5V | 11 |
| 13 | .8V | ----- |
| 14 | 1.5V to 3.1V | 13 |
| 15 | 0V | ----- |
| 16 | .15V | ----- |

**IC5**

| PIN | VOLTAGE | NOTE |
|---|---|---|
| 1 | 5.2V | ----- |
| 2 | 1.3V to 5.2V | 14 |
| 3 | .4V | ----- |
| 4 | .15V | ----- |
| 5 | 1.4V | ----- |
| 6 | .03V | ----- |
| 7 | .07V | ----- |
| 8 | .08V | ----- |
| 9 | .08V | ----- |
| 10 | .15V | ----- |
| 11 | 0V | ----- |
| 12 | .6V to 4.4V | 1 |
| 13 | .6V to 4.4V | 1 |
| 14 | .2V to 5.1V | 1 |
| 15 | 5.2V | ----- |
| 16 | 0V | ----- |

**IC6**

| PIN | VOLTAGE | NOTE |
|---|---|---|
| 1 | 3V to 5.2V | 15 |
| 2 | .6V to 4.4V | 1 |
| 3 | .03V | ----- |
| 4 | 2V | ----- |
| 5 | 4.6V | ----- |
| 6 | 1.3V | ----- |
| 7 | 1.4V | ----- |
| 8 | 1.4V | ----- |
| 9 | 1.4V | ----- |
| 10 | 0V | ----- |
| 11 | .15V | ----- |
| 12 | 2.2V | ----- |
| 13 | 3V to 4.6V | 16 |
| 14 | 2.8V | ----- |
| 15 | .7V | ----- |
| 16 | .4V | ----- |

| TRANSISTOR | | VOLTAGE | NOTE |
|---|---|---|---|
| Q4 | E | 0V | ----- |
| | B | .3V to .7V | 1 |
| | C | 0V to 5.2V | 1 |
| Q5 | E | 8.0V | ----- |
| | B | 8.0V | ----- |
| | C | 0V to 3.7V | 1 |
| Q6 | E | 0V | ----- |
| | B | .08V | ----- |
| | C | 5.1V | ----- |
| Q7 | E | 0V | ----- |
| | B | .65V | ----- |
| | C | .15V | ----- |
| Q9 | E | 5.2V | ----- |
| | B | 6.0V | ----- |
| | C | 9.0V | ----- |

**NOTES:**

VOLTAGES TAKEN WITH VTVM, GAME SWITCH IN "B" POSITION (TENNIS), PLAYERS SWITCH IN "4", SOUND ON, PLAYERS CENTERED AND "BALL" VOLLEYING BETWEEN.

1. VOLTAGE VARIES WITH BALL SPEED & DISTANCE TRAVELED.
2. VOLTAGE VARIES WITH RIGHT OR LEFT BALL CONTROL.
3. VOLTAGE VARIES WITH LEFT WALL POSITION CONTROL.
4. VOLTAGE VARIES WITH LOWER REBOUND CONTROL.
5. VOLTAGE VARIES WITH UPPER REBOUND CONTROL.
6. VOLTAGE VARIES WITH GOAL POSITION CONTROL.
7. VOLTAGE VARIES WITH RIGHT WALL POSITION CONTROL.
8. VOLTAGE VARIES WITH RIGHT PLAYER HORIZONTAL POSITION.
9. VOLTAGE VARIES WITH LEFT PLAYER HORIZONTAL POSITION.
10. VOLTAGE VARIES WITH RIGHT PLAYER VERTICAL POSITION.
11. VOLTAGE VARIES WITH LEFT PLAYER VERTICAL POSITION.
12. VOLTAGE VARIES WITH RIGHT FIXED PLAYER POSITION.
13. VOLTAGE VARIES WITH LEFT FIXED PLAYER POSITION.
14. VOLTAGE VARIES WITH BLANKING CENTERING & WIDTH.
15. VOLTAGE VARIES WITH HORIZONTAL SCORE POSITION.
16. VOLTAGE VARIES WITH VERTICAL SCORE POSITION.

## IC BASIC FUNCTIONS

**IC1**

A. Voltage Regulator
B. Vertical Sync Generator
C. Horizontal Sync Generator
D. Right Wall Generator
E. Rebound Circuitry

**IC2**

A. Right Player Generator
B. Left Player Generator

**IC3**

A. Left Wall Generator
B. Ball Generator

* Not used in YF7010

**IC4***

A. Right Back Court Player Generator
B. Left Back Court Player Generator

**IC5**

A. Video Summer
B. Video Output
C. Audio Pulse Generator
D. Logic Circuitry

**IC6***

A. Automatic Scoring Circuitry

Fig. 3-5. Voltage charts and IC functions for the YF7010 and YF7015.

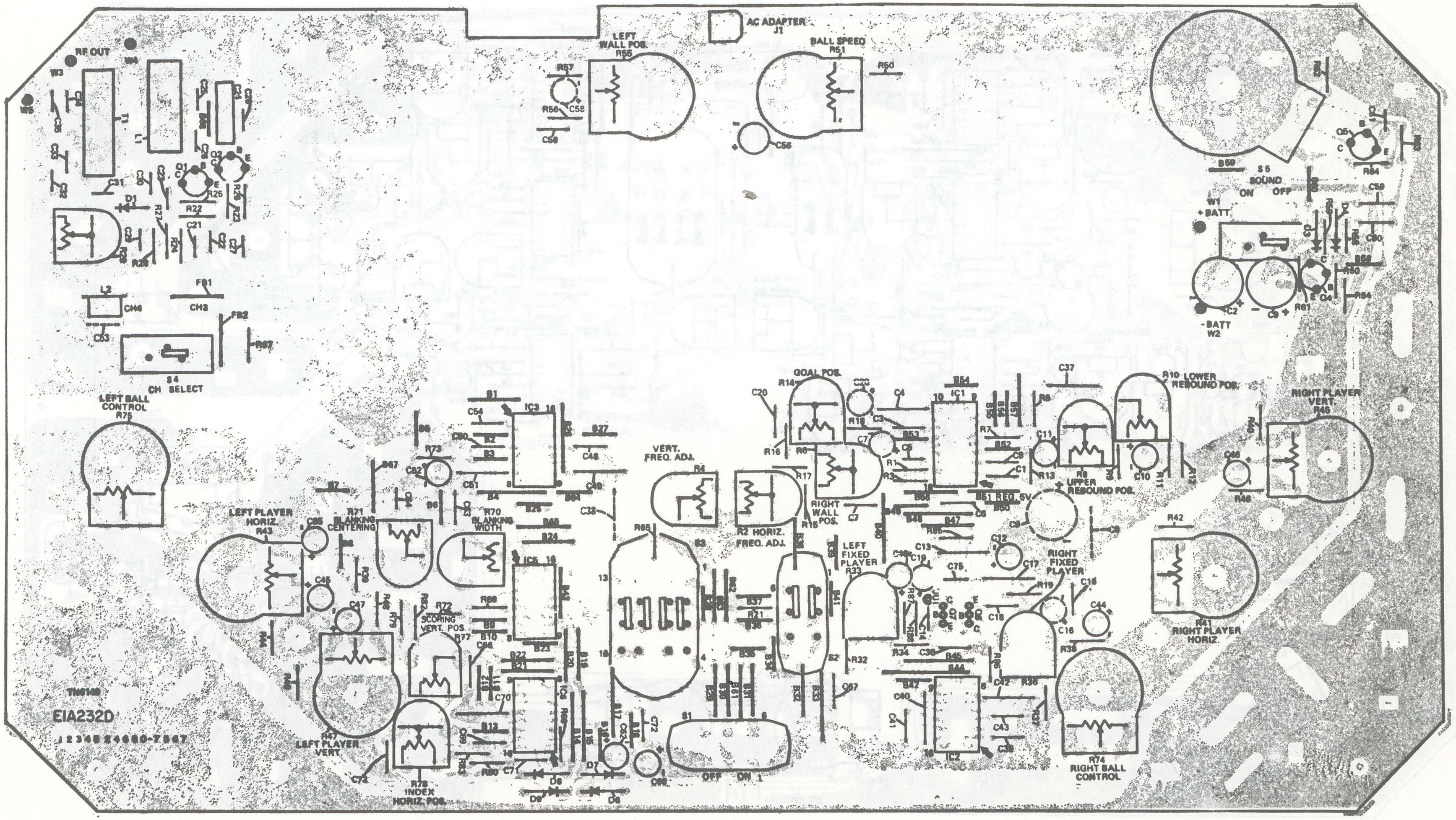



Fig. 3-6. PC board component view of the YF7010.

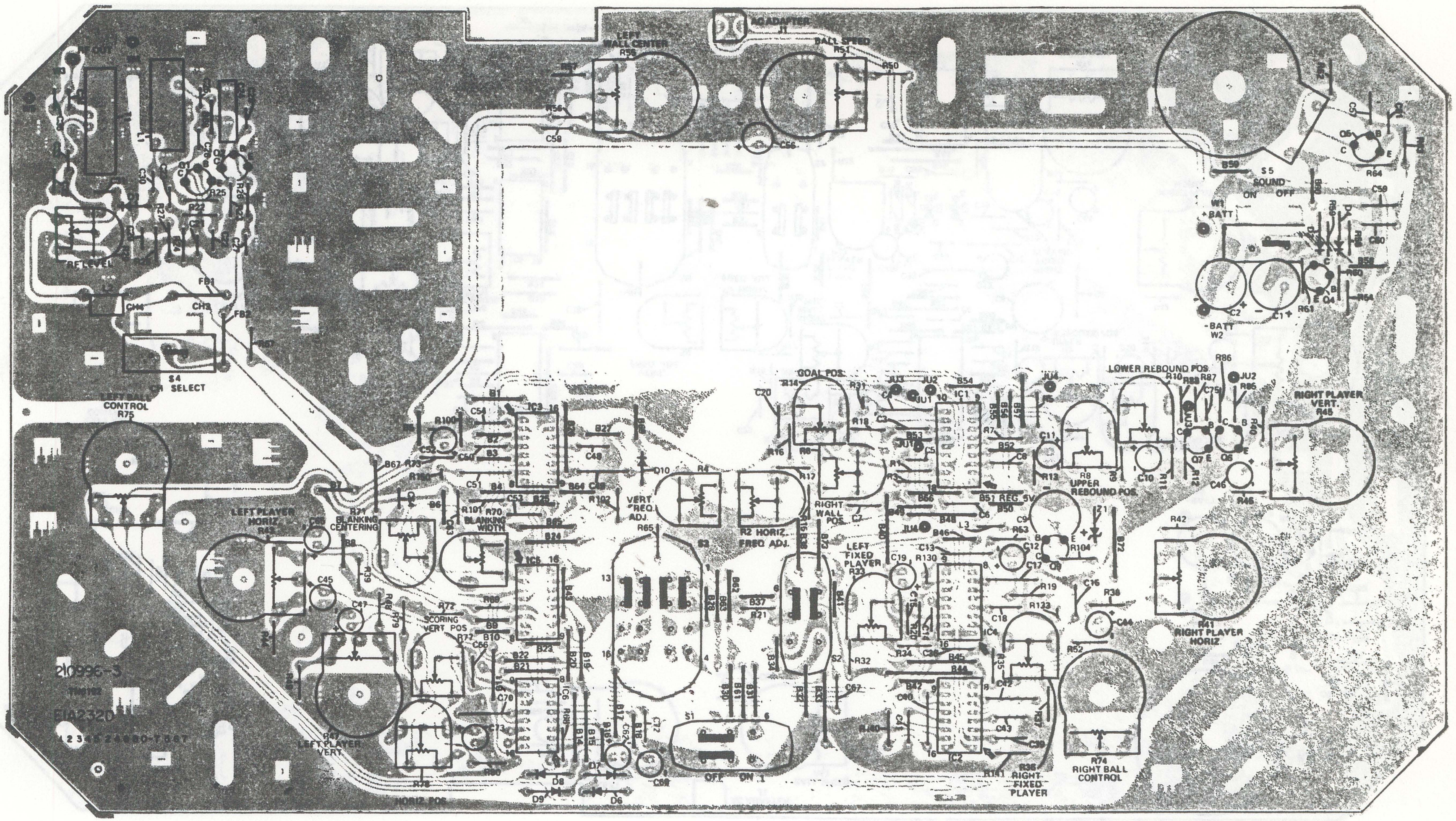



Fig. 3-7. PC board component view of the YF7015.

- Check for 9V at pin 2 of IC1 and 5V at pin 3 of IC1.
- If 9V is found at pin 2 but no 5V at pin 3, replace IC1.

**Blank Screen—No Snow**

- Check pin 16 of IC1 with a scope for horizontal sync pulses.
- Check pin 14 of IC1 with a scope for vertical sync pulses.
- If vertical or horizontal pulses are missing, check related components and substitute IC1.
- Check for video at pin 5 of IC5.
- If video is present at pin 5, check components in RF section, such as D1.
- If video is not present at pin 5, check for video at pins 7, 8, 9, 10, and 16 of IC5.
- Replace IC5.

**Right Frontcourt Player Not on Screen**

- Adjust the horizontal and vertical player position controls.
- Check the horizontal waveform at pin 4 of IC2 (C43).
- Check vertical waveform at pin 7 of IC2 (C42).
- Check components R38, R41, R42, C44, R40, R45, R56, and C46.
- Substitute IC2.

**Left Frontcourt Player Not on Screen**

- Adjust horizontal and vertical player position controls.
- Check horizontal waveform at pin 13 (C41).
- Check vertical waveform at pin 10 (C40).
- Check components R39, R43, R44, C45, R48, R47, R49, and C47.
- Substitute IC2.

**Right Backcourt Player Not on Screen**

- Adjust horizontal position control.
- Check horizontal waveform at pin 4 of IC4 (C18).
- Check vertical waveform at pin 7 of IC4 (C17).
- Check components R35, R36, R37, and C16.
- Substitute IC4.

**Left Backcourt Player Not on Screen**

- Adjust horizontal position control.
- Check horizontal waveform at pin 13 of IC4 (C14).
- Check vertical waveform at pin 10 of IC4 (C13).
- Check components R32, R33, R34, and C15.
- Replace IC4.

**Left Wall Not on Screen**

- Adjust left wall position control.
- Check horizontal waveform at pin 13 of IC3 (C48).
- Check vertical waveform at pin 10 of IC3 (C49).
- Check components R65, R57, R56, R55, and C58.
- Substitute IC3.

**Right Wall Not on Screen**

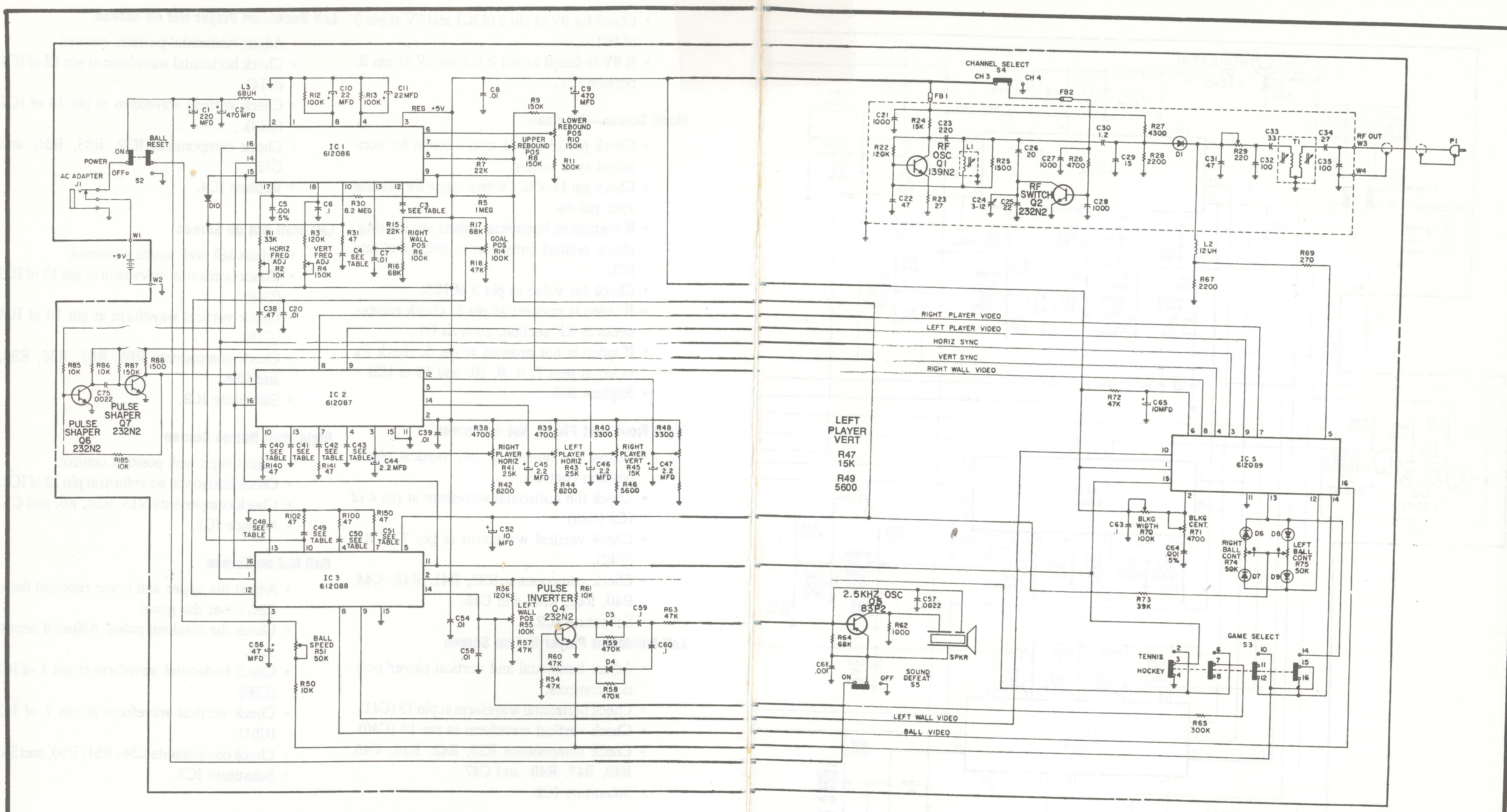
- Adjust right wall position control.
- Check horizontal waveform at pin 12 of IC1.
- Check components R15, R16, R6, and C7.
- Replace IC1.

**Ball Not on Screen**

- Adjust the upper and lower rebound lines, then reset the game.
- Check the blanking pulse. Adjust if necessary.
- Check horizontal waveform at pin 4 of IC3 (C50).
- Check vertical waveform at pin 7 of IC3 (C51).
- Check components C56, R51, R50, and S1.
- Substitute IC3.

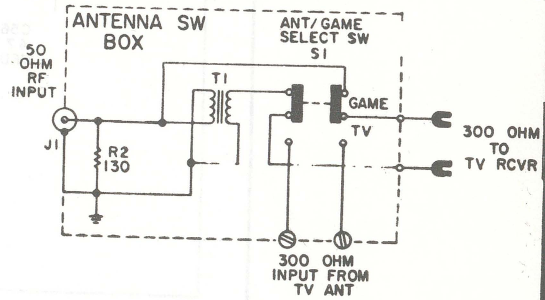
**Game Display Rolling Vertically**

- Adjust the TV set, with a weak station signal, for good vertical locking.
- Check the vertical pulses at pin 4 of IC5 with an oscilloscope.
- Adjust the vertical frequency control with a frequency counter connected to pin 14 of IC1. Adjust it for 60 ± 1 Hz.
- Replace IC5.




| TIMING CAPACITORS | | GROUP 1 IC'S | GROUP 2 IC'S | GROUP 3 IC'S | GROUP 4 IC'S |
|---|---|---|---|---|---|
| HORIZ | C3, C41, C43, C48, & C50 | .0022 MFD | .0027 MFD EXCEPT C3 = .0022 MFD | .0018 MFD | .0027 MFD |
| VERT | C4, C40, C42, C49, & C51 | .47 MFD | .56 MFD | .39 MFD | .68 MFD |

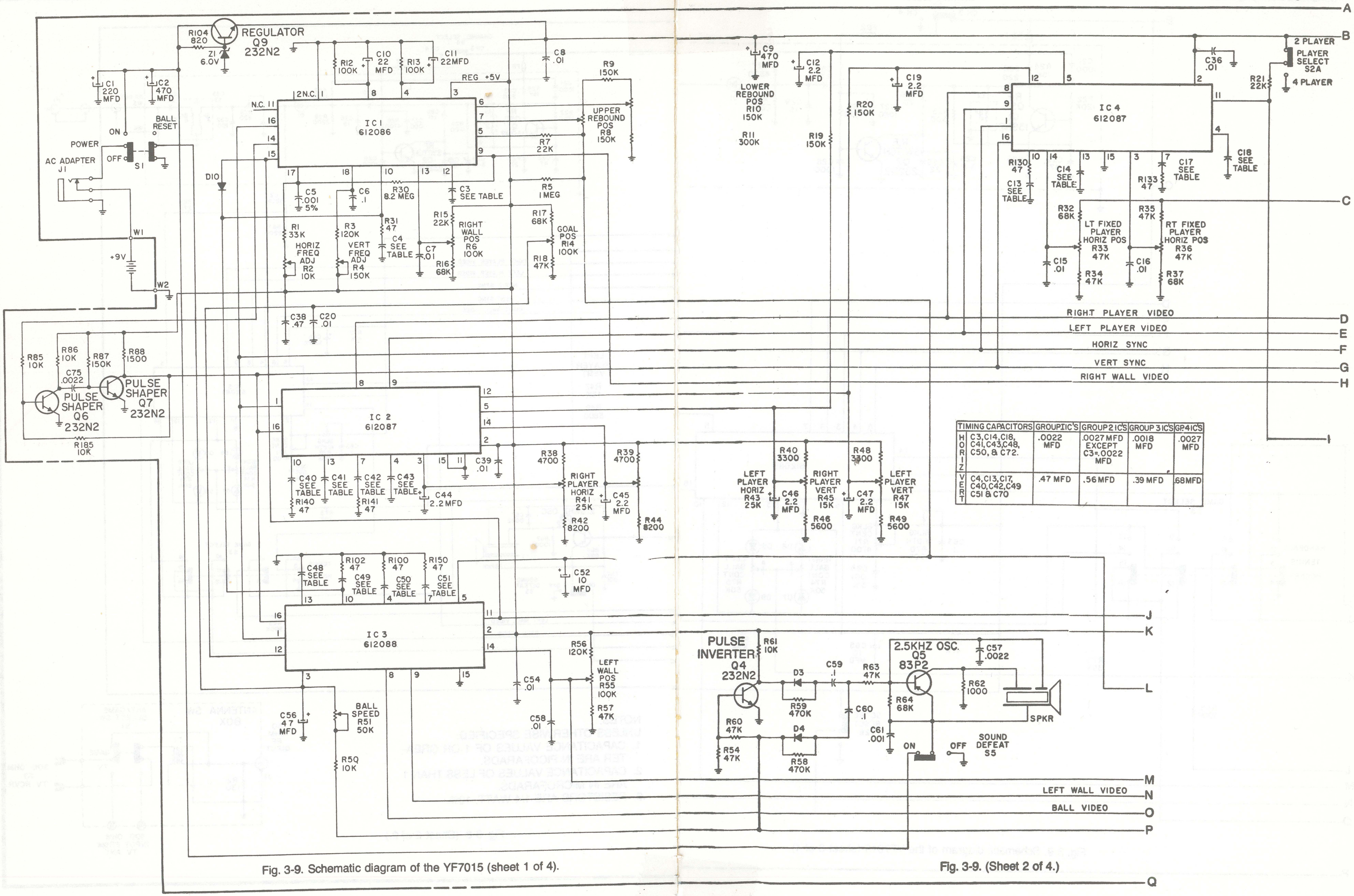
Fig. 3-8. Schematic diagram of the YF7010 (sheet 1 of 2).




NOTES:
UNLESS OTHERWISE SPECIFIED:
1. CAPACITANCE VALUES OF 1 OR GREATER ARE IN PICOFARADS.
2. CAPACITANCE VALUES OF LESS THAN 1 ARE IN MICROFARADS.
3. RESISTORS ARE 1/4 WATT, 10%.

Fig. 3-8. (Sheet 2 of 2.)

Continued on page 90.




| TIMING CAPACITORS | GROUP1 IC'S | GROUP2 IC'S | GROUP 3 IC'S | GP.4 IC'S |
|---|---|---|---|---|
| HORIZ C3, C14, C18, C41, C43, C48, C50, & C72. | .0022 MFD | .0027 MFD EXCEPT C3=.0022 MFD | .0018 MFD | .0027 MFD |
| VERT C4, C13, C17, C40, C42, C49 C51 & C70 | .47 MFD | .56 MFD | .39 MFD | .68 MFD |

Fig. 3-9. Schematic diagram of the YF7015 (sheet 1 of 4).

Fig. 3-9. (Sheet 2 of 4.)

Continued from page 89.

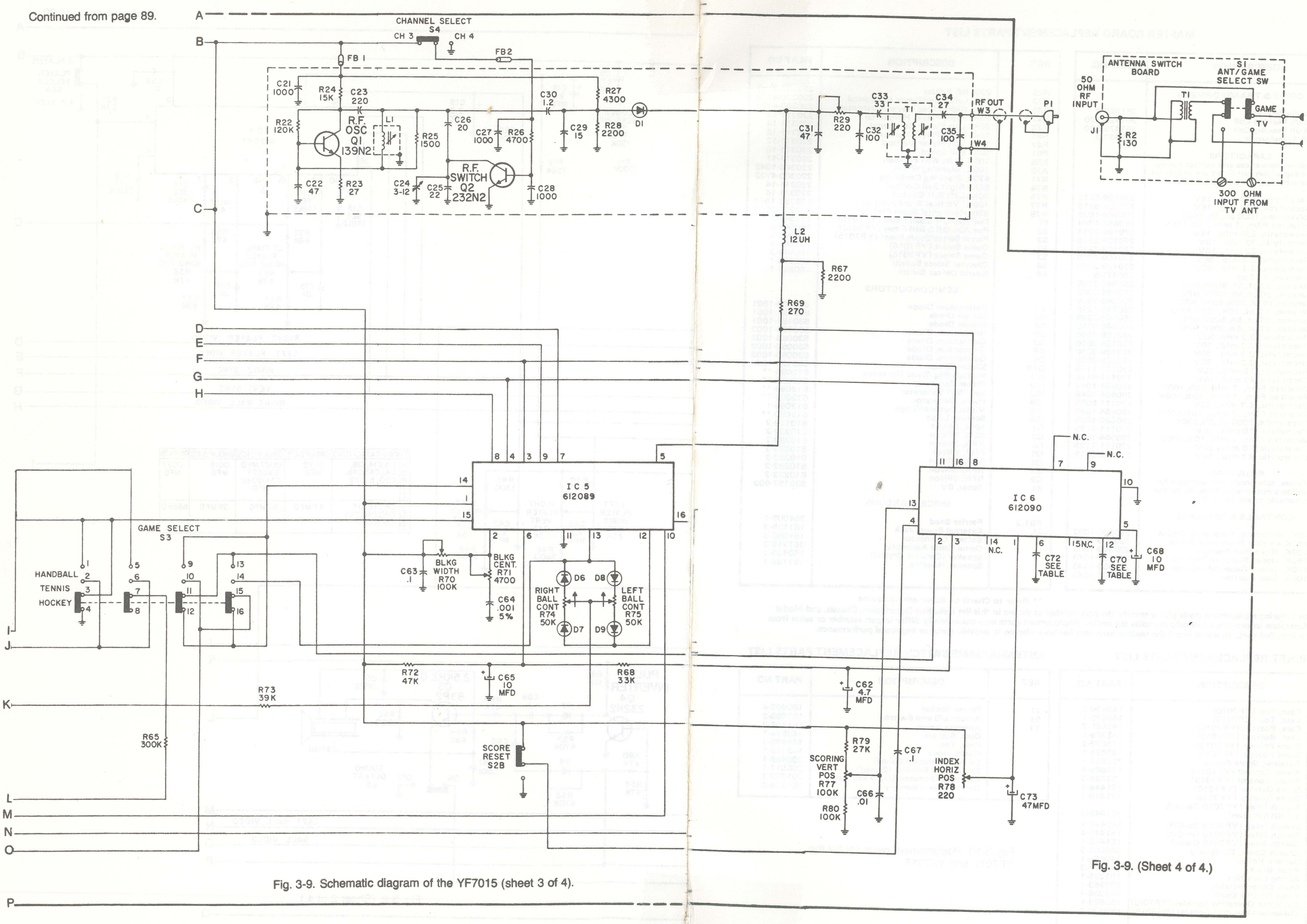



Fig. 3-9. Schematic diagram of the YF7015 (sheet 3 of 4).

Fig. 3-9. (Sheet 4 of 4.)

## MASTER BOARD REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | COILS & TRANSFORMERS | |
| L1 | Oscillator Coil | 361495-2 |
| L2 | 12 uh Peaking Coil | 361425-120 |
| L3 | 68 uh Peaking Coil | 361475-680 |
| T1 | RF Transformer | 361467-2 |
| | CAPACITORS | |
| | Values, tolerances and voltage ratings for capacitors not listed are shown on the schematic or are 10%, 500V. | |
| C1 | Electrolytic, 470 mfd., 16V | 270109-5215 |
| C2 | Electrolytic, 470 mfd., 16V | 270109-5215 |
| C5 | Polystyrene,1000 pf.,5%,150V | 250589-1025 |
| C6 | Metalized Film, .1 mfd.,10%,100V | 250654-1049 |
| C9 | Electrolytic, 220 mfd., 16V | 270109-2215 |
| C10 | Electrolytic, 22 mfd., 10V | 270109-2110 |
| C11 | Electrolytic, 22 mfd., 10V | 270109-2110 |
| C12 | Electrolytic, 2.2 mfd., 50V | 270109-2050 |
| C19 | Electrolytic, 2.2 mfd., 50V | 270109-2050 |
| C24 | Trimmer, 3-15 pf. | 250371-6 |
| C25 | Ceramic, 22 pf.,5%,500V,NPO | 250546-2205 |
| C26 | Ceramic, 20 pf.,5%,500V,NPO | 250546-2005 |
| C29 | Ceramic,15 pf.,10%,500V,NPO | 250546-1509 |
| C30 | Ceramic, 1.2 pf.,10%,500V,NPO | 250546-1296 |
| C33 | Ceramic, 33 pf.,5%,500V,NPO | 250546-3305 |
| C34 | Ceramic, 27 pf.,5%,500V,NPO | 250546-2705 |
| C44 | Electrolytic, 2.2 mfd.,50V | 270109-2050 |
| C45 | Electrolytic, 2.2 mfd., 50V | 270109-2050 |
| C46 | Electrolytic, 2.2 mfd., 50V | 270109-2050 |
| C47 | Electrolytic, 2.2 mfd., 50V | 270109-2050 |
| C52 | Electrolytic, 10 mfd., 25V | 270111-1125 |
| C56 | Electrolytic, 47 mfd., 16V | 270111-5115 |
| C59 | Metalized Film, .1 mfd.,10%,100V | 250654-1049 |
| C60 | Metalized Film, .1 mfd., 10%,100V | 250654-1049 |
| C62 | Electrolytic, 4.7 mfd., 50V | 270111-5050 |
| C63 | Metalized Film, .1 mfd., 10%,100V | 250654-1049 |
| C64 | Polystyrene, 1000 pf.,5%,150V | 250589-1025 |
| C65 | Electrolytic, 10 mfd., 25V | 270111-1125 |
| C67 | Metalized Film, .1 mfd.,10%,100V | 250654-1049 |
| C68 | Electrolytic, 10 mfd., 25V | 270111-1125 |
| C73 | Electrolytic, 47 mfd., 16V | 270109-5115 |
| | RESISTORS | |
| | Values, tolerances, and wattages for resistors not listed are shown on the schematic or are 5%, ¼W. | |
| | CONTROLS & SWITCHES | |
| R2 | 10K, Horizontal Frequency Adjust | 220300-1032 |
| R4 | 150K,Vertical Frequency Adjust | 220300-1543 |
| R6 | 100K, Right Wall Position | 220300-1043 |
| R8 | 150K, Upper Rebound Position | 220300-1543 |
| R10 | 150K, Lower Rebound Position | 220300-1543 |
| R14 | 100K, Goal Position | 220300-1043 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| R29 | 220, RF Adjust | 220300-2213 |
| R33 | 47K, Left Fixed Player Horizontal | 220300-4733 |
| R36 | 47K, Right Fixed Player Horizontal | 220300-4733 |
| R41 | 25K, Right Player Horizontal | 220311-13 |
| R43 | 25K, Left Player Horizontal | 220311-13 |
| R45 | 15K, Right Player Vertical | 220311-12 |
| R47 | 15K, Left Player Vertical | 220311-12 |
| R51 | 50K, Ball Speed | 220311-10 |
| R55 | 100K, Left Wall Position | 220311-11 |
| R70 | 100K, Blanking Width | 220300-1043 |
| R71 | 4700, Blanking Centering | 220300-4723 |
| R74 | 50K, Right Ball Control | 220311-14 |
| R75 | 50K, Left Ball Control | 220311-14 |
| R77 | 100K, Vertical Score Position | 220300-1043 |
| R78 | 220, Horizontal Score Position | 220300-2213 |
| S1 | Pwr./On-Off & Ball Reset (YF7015) | 160546-3 |
| S2 | Pwr./On-Off & Ball Reset (YF7010) | 160546-3 |
| S2 | Player Select/Score Reset (YF7015) | 160546-3 |
| S3 | Game Select (YF7010) | 160546-1 |
| S3 | Game Select (YF7015) | 160546-2 |
| S4 | Channel Select Switch | 160556-1 |
| S5 | Sound Defeat Switch | 160556-1 |
| | SEMICONDUCTORS | |
| D1 | Germanium Diode | 530105-1001 |
| D3 | Silicon Diode | 530181-1001 |
| D4 | Silicon Diode | 530181-1001 |
| D6 | Germanium Diode | 530065-1002 |
| D7 | Germanium Diode | 530065-1002 |
| D8 | Germanium Diode | 530065-1002 |
| D9 | Germanium Diode | 530065-1002 |
| D10 | Silicon Diode | 530181-1001 |
| IC1 | Voltage Reg./Sync Generator | 612086-** |
| IC2 | Player Generator | 612087-** |
| IC3 | Ball/Wall Generator | 612088-** |
| IC4 | Player Generator | 612087-** |
| IC5 | Video Summer/Logic | 612089-1 |
| IC6 | Scoring Logic | 612090-** |
| Q1 | NPN, Silicon | 610139-2 |
| Q2 | NPN, Silicon | 610232-2 |
| Q4 | NPN, Silicon | 610232-2 |
| Q5 | PNP, Silicon | 610083-2 |
| Q6 | NPN, Silicon | 610232-2 |
| Q7 | NPN, Silicon | 610232-2 |
| Q9 | NPN, Silicon | 610232-2 |
| Z1 | Zener, 6V | 530157-609 |
| | MISCELLANEOUS | |
| FB1,2 | Ferrite Bead | 364005-1 |
| J1 | External Power Jack | 181139-2 |
| | Battery Connector | 181096-3 |
| | Game Cable Assembly | 361218-3 |
| | Speaker (Ceramic Crystal) | 560406-1 |
| | Speaker Housing | 181189-1 |

** Refer to Charts on Schematic Diagrams

**Note: When ordering replacement parts please specify the part number as shown in this list including Description, Chassis, and Model Number. Complete information will help expedite the order. Replacement parts may occasionally differ in part number or value from the Factory installed part. In either event the replacement part has been chosen to provide equal or improved performance.**

## CABINET REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | Case, Top (YF7010) | 143670-2 |
| | Case, Top (YF7015) | 143670-1 |
| | Case, Bottom (YF7010) | 143669-2 |
| | Case, Bottom (YF7015) | 143369-1 |
| | Score Pointer (YF7010) | 143675-2 |
| | Score Pointer (YF7015) | 143675-1 |
| | Retainer, Score Pointer | 732937-1 |
| | Knob, Control (YF7010) | 143689-4 |
| | Knob, Control (YF7015) | 143689-3 |
| | Score Overlay (YF7010) | 151448-2 |
| | Score Overlay (YF7015) | 151448-1 |
| | Switch Inlay (YF7010 Game & YF7015 Players) | 151449-3 |
| | Switch Inlay (YF7015 On-Off) | 151449-2 |
| | Switch Inlay (YF7010 On-Off) | 151449-4 |
| | Switch Inlay (YF7015 Game) | 151449-1 |
| | Chassis Cover, Cardboard | 643602-2 |
| | Battery Holder | 142658-1 |
| | Foot, Black | 141737-3 |
| | Spring Lock Nut | 103235-1 |
| | Stud, Cover Holding | 732953-1 |
| | Cross Pin (for Stud) | 103236-1 |
| | Customer Operating Booklet (YF7010) | IB2899-1 |
| | Customer Operating Booklet (RF7015) | IB2900-2 |

## ANTENNA/GAME SWITCH REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| J1 | Phono Socket | 180902-4 |
| S1 | Antenna/Game Switch | 160499-2 |
| T1 | Antenna Balun | 361108-2 |
| | Case, Bottom | 143674-1 |
| | Case, Top | 143676-1 |
| | Plastic Hook | 143719-1 |
| | Screw, Terminal (2 used) | 200495-1 |
| | Solderless TErminal (2 used) | 200517-1 |
| | Complete Antenna/Game Sw. Ass'y. | 701702-1 |
| | Game Cable Assembly | 361218-3 |

Fig. 3-10. Replacement parts list for the YF7010 and YF7015.

### Game Display Will Not Lock Horizontally

- Adjust the TV set, with a weak station signal, for good horizontal locking.
- Check the horizontal pulses at pin 3 of IC5 with an oscilloscope.
- Adjust the horizontal frequency control with a frequency counter connected to pin 16 of IC1. Adjust it for 15.734 kHz ± 30 Hz.
- Substitute IC5.

### Character Jitter in the Display

- Add a 47Ω resistor in series with the vertical timing capacitor for the character that is jittering.

## ODYSSEY MODEL BG7500

This TV game features hockey, tennis, and smash plus switchable skill levels of novice, intermediate, and expert which automatically adjusts the player size, speed of ball, and deflection of the ball.

Automatic features include on-screen scoring, which awards a point to the appropriate player or team each time the ball leaves the playing area. Automatic serve will return the ball into play from the side that was awarded the point. After either side has scored 15 points (winning score) the ball will continue to be served but neither player can return it.

During play a different audio tone is generated each time the ball hits a player, the ball hits a wall, or a point is scored. The sound cannot be turned on or off.

### GAME OPERATION

Connect the 300Ω twin lead from the antenna/game switch to the 300Ω antenna terminals of a properly adjusted TV receiver. Connect the game cord cable from the Odyssey unit to the antenna/game switch and place the game/TV switch in the game position.

Place the channel switch on the game to either channel 3 or 4 and the TV set's VHF channel selector to the same channel.

Set the game switch to the center position and skill switch to the skill level desired. Move the power/reset switch to the center position and fine tune the TV set if necessary. When play is ready to begin, move the power/reset switch to the reset position and allow it to return to the center position. The score is now set to zero and the game begins. When either contestant reaches 15 points the players will be unable to return the ball and a new game will have to be started.

### SERVICE ADJUSTMENTS

Refer to Fig. 3-11 for the location of test points, adjustments, and components.

#### 2 MHz Oscillator

Connect a frequency counter to pin 17 of IC1. Adjust C4 for 2.01 MHz ± 20.1 kHz.

#### Channel 3 and 4 RF Oscillator

1. Connect the game to a TV receiver and defeat the set's AFT.
2. Place the TV channel selector to channel 3, mechanically center the fine tuning, and set the game channel select switch to channel 3.
3. While observing the game display, adjust L1 for optimum response.
4. Change the TV set and the game to channel 4 operation.
5. While observing the game display, adjust L1 and C14 for optimum response. Little change will be noticed while adjusting C14.
6. Repeat steps 2 through 5 until channel 3 and 4 game displays are equal video quality.

A schematic for the BG7500 and IC1 voltage chart is shown in Fig. 3-12, while the parts list for the BG7500 is in Fig. 3-13.

## ODYSSEY MODEL BH7510

The BH7510 can be powered by either 6 C-cells or an optional AC to DC 9V adapter.

The BH7510 features games of smash, tennis, hockey, and practice and as an extra challenge has switchable skill levels of amateur and pro, which automatically adjust player size and speed of the ball. Deflection of the ball is determined by where it strikes the player.

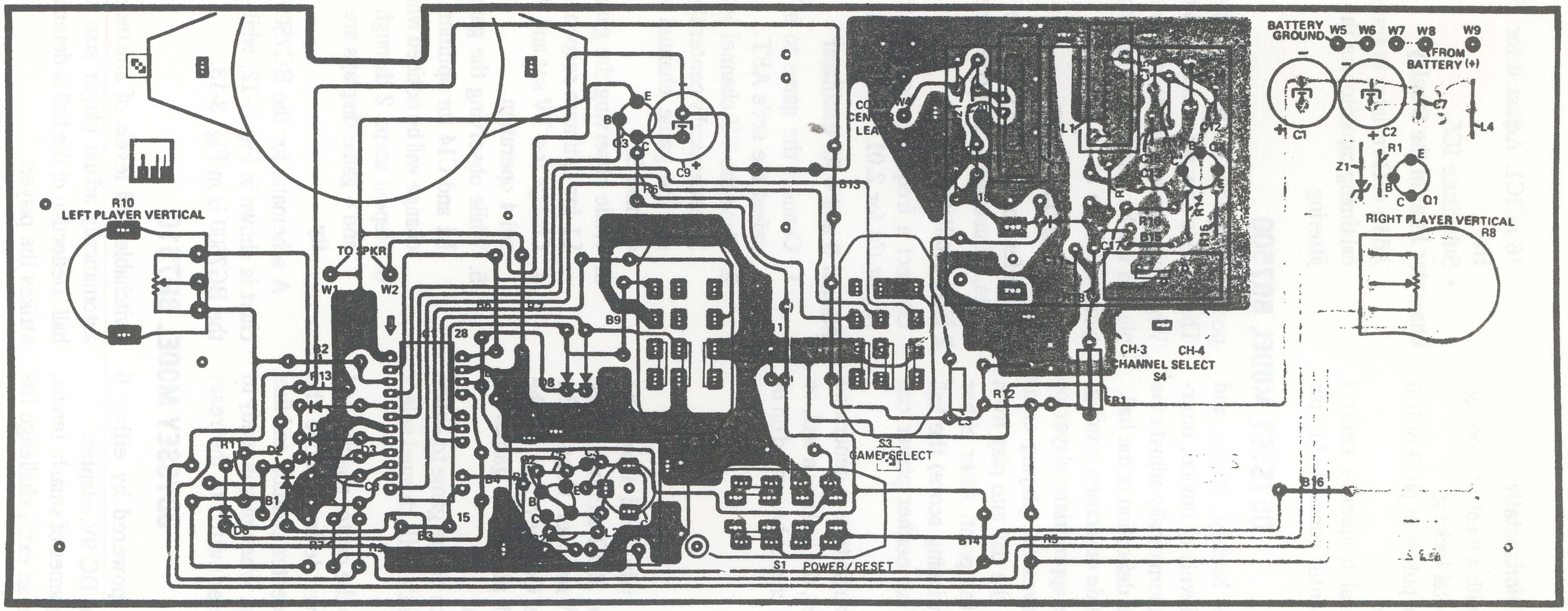



Fig. 3-11. PC board diagram of the BG7500.

Automatic features include on-screen scoring, which awards a point to the appropriate player or team each time the ball leaves the playing area. Automatic serve will return the ball into play from the side that was awarded the point. After either side has scored 15 points the ball will continue to be served but neither player will be able to return it.

During play a different audio tone is generated each time the ball hits a player, a wall, or a point is scored. No provisions are made to turn the sound on or off.

## CIRCUIT OPERATION IN TENNIS

Connect the 300Ω twin lead from the antenna game switch to the 300Ω VHF antenna terminals of a properly adjusted and operating television receiver. Connect the game cord cable from the Odyssey unit to the antenna/game switch and place the game/TV switch in the game position.

Place the channel switch on the Odyssey to either channel 3 or 4 and the television VHF channel selector to the same channel.

Set game switch S3 (Fig. 3-14) to the center position and skill switch S2 to the desired skill level. Move power/reset switch S1 to the center position and fine tune the television if necessary. When play is ready to begin, move power/reset switch S1 to the reset position and allow it to return to the center position. The score is now set to zero and the game begins. When either contestant reaches 15 points the players will be unable to return the ball and a new game will have to be started.

## SERVICE ADJUSTMENTS

Do not perform any adjustments to the video game board until you have checked the operation using a properly operating TV receiver. Verify that the batteries or power supply are furnishing the proper voltage to the circuitry. Use nonmetallic tuning tools for all adjustments. Refer to Figs. 3-15 and 3-16 for the location of test points, adjustments, and components outlined in the following procedures. Figure 3-15 is the PC board diagram for the game circuitry, while Fig. 3-16 illustrates component locations on the RF modulator subassembly.

### 2 MHz Oscillator

1. Connect a frequency counter to pin 17 of IC1.
2. Adjust C4 for 2.01 MHz ±20 kHz.

### Channel 3 & 4 RF Oscillator

1. Connect the Odyssey to an operating TV and defeat the TV AFT.
2. Place the TV channel selector to channel 3, mechanically center the fine tuning, and set the Odyssey channel select switch to channel 3.
3. While observing the game display, adjust L3 for optimum response.
4. Change the TV and the Odyssey to channel 4 operation.
5. While observing the game display, adjust C5 for optimum response.
6. Repeat steps 2 through 5 until channel 3 and 4 game displays are equal in quality.

## TROUBLESHOOTING

As in any troubleshooting procedure, the first step is to isolate the defect to as small an area as possible. Using a logical approach, this should not be too difficult due to the simplicity of the circuitry. Basically, there are six major circuit areas in the BH7510: game chip IC1, voltage regulator Q1, 2 MHz oscillator Q2, sound amplifier Q3, the RF modulator subassembly, and the antenna switch box. Systematically, you can eliminate several of the major circuit areas at the onset. For example, if there is *no sound*, the problem could be in either the game chip circuitry or the sound amplifier—maybe the speaker itself. This eliminates four of the major circuit areas, leaving only two to deal with. Simple signal-injection and signal-tracing techniques can localize the trouble in a matter of minutes.

Troubleshooting defects related to game chip IC1 can be difficult. About all one can do it to check voltages at each pin connection and check expected outputs with an oscilloscope. Figure 3-17 contains nominal voltages for IC1. The voltage chart is composed of three columns, indicating pin number, voltage, and special notes. Notes are referenced by number designations, which are defined in the lower portion of the illustration. For example, pin 7 of IC1 should read 6.4V only with the skill switch in the practice or amateur positions because of the reference to *note 1*.

A schematic of the overall system is shown in Fig. 3-18. This diagram details circuitry located on the game board and the antenna switch. The RF

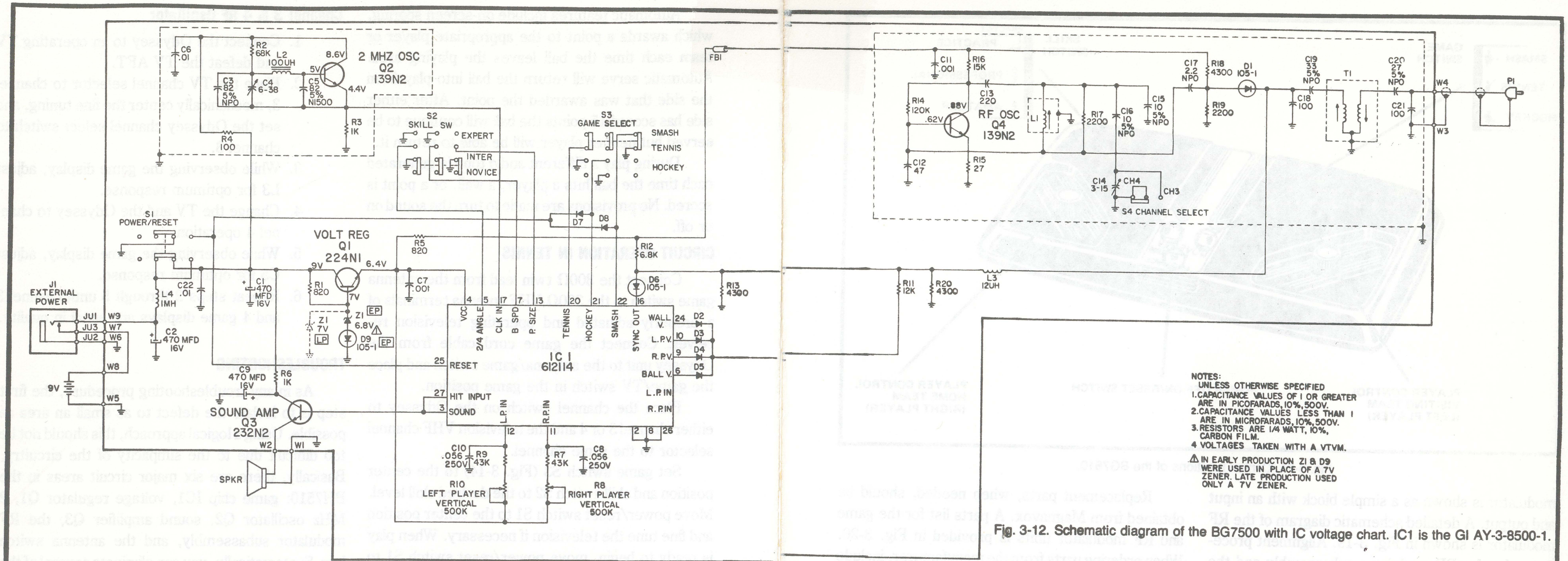



Fig. 3-12. Schematic diagram of the BG7500 with IC voltage chart. IC1 is the GI AY-3-8500-1.

IC1 VOLTAGE CHART

| PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE |
|---|---|---|---|---|---|
| 1 | Not Used | ----- | 15 | Not Used | ----- |
| 2 | Ground | ----- | 16 | 5.8V | ----- |
| 3 | Sound | ----- | 17 | 4.4V | ----- |
| 4 | 6.4V | ----- | 18 | Not Used | ----- |
| 5 | 6.4V | 1 | 19 | Not Used | ----- |
| 6 | B. Video | ----- | 20 | 6.2V | 6 |
| 7 | 6.4V | 2 | 21 | 6.2V | 7 |
| 8 | Ground | ----- | 22 | 6.2V | 8 |
| 9 | R.P. Video | ----- | 23 | Not Used | ----- |
| 10 | L.P. Video | ----- | 24 | W. Video | ----- |
| 11 | 1.2V to 5.4V | 3 | 25 | 6.2V | ----- |
| 12 | 1.2V to 5.4V | 4 | 26 | Ground | ----- |
| 13 | 6.2V | 5 | 27 | Sound | ----- |
| 14 | Not Used | ----- | 28 | Not Used | ----- |

VOLTAGE CHART NOTES:

1. Present only with Skill Switch in Novice Position.
2. Present only with Skill Switch in Intermediate or Novice Position.
3. Varies with Right Player Control.
4. Varies with Left Player Control.
5. Present only with Skill Switch in Expert or Novice Position.
6. Present only with Game Switch in Hockey or Smash Position.
7. Present only with Game Switch in Tennis or Smash Position.
8. Present only with Game Switch in Hockey or Tennis Position.

**Note: When ordering replacement parts please specify the part number as shown in this list including Description, Chassis, and Model Number. Complete information will help expedite the order. Replacement parts may occasionally differ in part number or value from the Factory installed part. In either event the replacement part has been chosen to provide equal or improved performance.**

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | COILS & TRANSFORMERS | |
| L1 | Oscillator Coil | 361495-2 |
| L2 | Peaking Coil, 100 uh | 361444-1015 |
| L3 | Peaking Coil, 12 uh | 361425-120 |
| L4 | Peaking Coil, 1 mh | 361444-1029 |
| T1 | Bandpass Transformer | 361467-2 |
| | CAPACITORS<br>Values, tolerances and voltage ratings for capacitors not listed are shown on the schematic, or are 10%, 500V. | |
| C1 | Electrolytic, 470 mfd., 16V | 270109-5215 |
| C2 | Electrolytic, 470 mfd., 16V | 270109-5215 |
| C3 | Ceramic, 82 pf., 5%, 500V, NPO | 250549-8205 |
| C4 | Trimmer, 6-38 pf. | 260220-2 |
| C5 | Ceramic, 82 pf., 5%, 500V, N1500 | 250529-8205 |
| C8 | Metalized Polyester, .056 mfd., 10%, 250V | 250655-5639 |
| C9 | Electrolytic, 470 mfd., 16V | 270109-5215 |
| C10 | Metalized Polyester, .056 mfd., 10%, 250V | 250655-5639 |
| C14 | Trimmer, 3-15 pf. | 250371-8 |
| C15 | Ceramic, 10 pf., 5%, 500V, NPO | 250546-1005 |
| C16 | Ceramic, 10 pf., 5%, 500V, NPO | 250546-1005 |
| C17 | Ceramic, 2.2 pf., 10%, 500V, NPO | 250546-2297 |
| C19 | Ceramic, 33 pf., 5%, 500V, NPO | 250546-3305 |
| C20 | Ceramic, 27 pf., 5%, 500V, NPO | 250546-2705 |
| | RESISTORS<br>Values, tolerances, and wattages for resistors not listed are shown on the schematic, or are 5%, ¼W. | |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | CONTROLS & SWITCHES | |
| R8 | 500K, Right Player Control | 220337-3 |
| R10 | 500K, Left Player Control | 220337-3 |
| S1 | On-Off/Reset Switch | 160546-5 |
| S2 | Skill Switch | 160546-4 |
| S3 | Game Switch | 160546-4 |
| S4 | Channel Select Switch | 160556-1 |
| | SEMICONDUCTORS | |
| D1 | Germanium Diode | 530105-1001 |
| D2 thru 5 | Silicon Diode | 530181-1001 |
| D6 | Germanium Diode | 530105-1001 |
| D7,8 | Silicon Diode | 530181-1001 |
| D9 | Germanium Diode | 530105-1001 |
| IC1 | Integrated Circuit | 612114-1 |
| Q1 | NPN Silicon | 610224-1 |
| Q2 | NPN Silicon | 610139-2 |
| Q3 | NPN Silicon | 610232-2 |
| Q4 | NPN Silicon | 610139-2 |
| Z1 | Zener Diode, TV | 530073-1039 |
| FB1 | Ferrite Bead | 364005-1 |
| J1 | External Power Jack | 181139-2 |
| | Game Cable Assembly | 461218-4 |
| | Battery Connector | 181096-3 |
| | Speaker, 2¼" | 580108-1 |
| | Speaker Holding Strap | 143856-1 |

Fig. 3-13. Parts list for the BG7500.

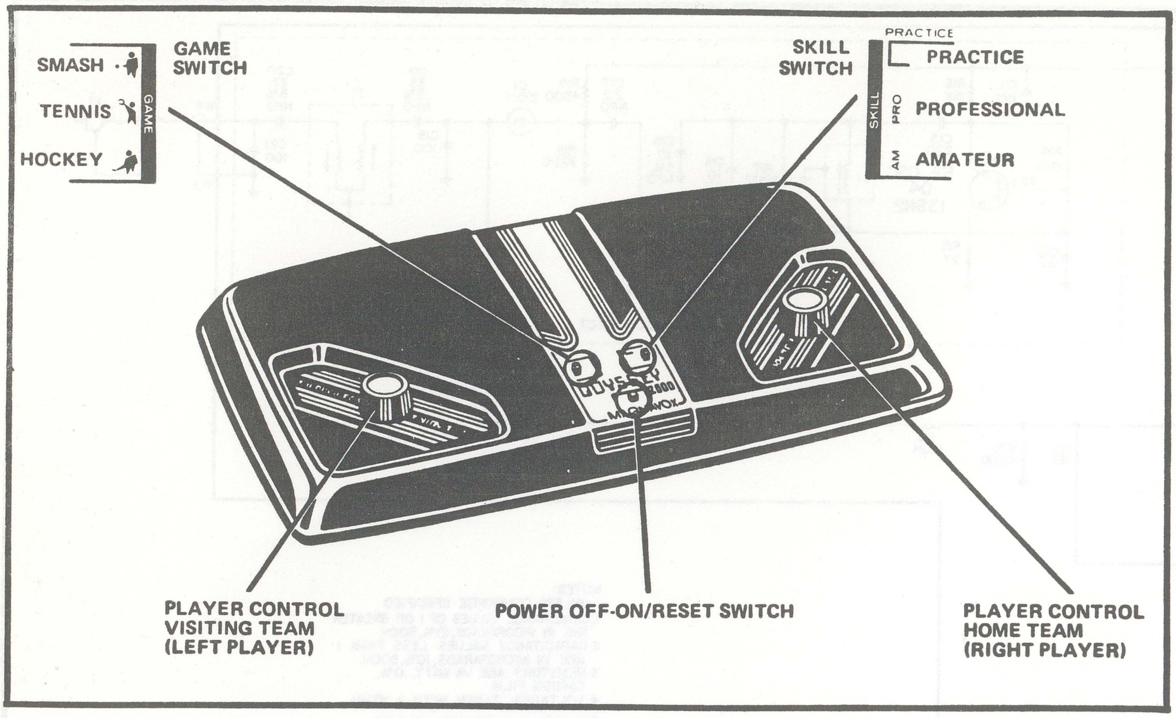



Fig. 3-14. Control functions of the BG7510.

modulator is shown as a simple block with an input and output. A detailed schematic diagram of the RF modulator is shown in Fig. 3-19. Alignment procedures for the RF modulator subassembly and the game board are covered under the section entitled *Service Adjustments*.

Replacement parts, when needed, should be obtained from Magnavox. A parts list for the game and RF modulator units is provided in Fig. 3-20. When ordering parts from the manufacturer, include the information given in all three columns for each component.

## ODYSSEY MODEL BH7511

The BH7511 Odyssey is powered by an AC-to-DC, 9V, 100 mA adaptor. Its features include a selection of eight games that allows the operator to choose from hockey, soccer, gridball, basketball practice, basketball, smash, smash practice, or tennis. For an extra challenge, the BH7511 has a

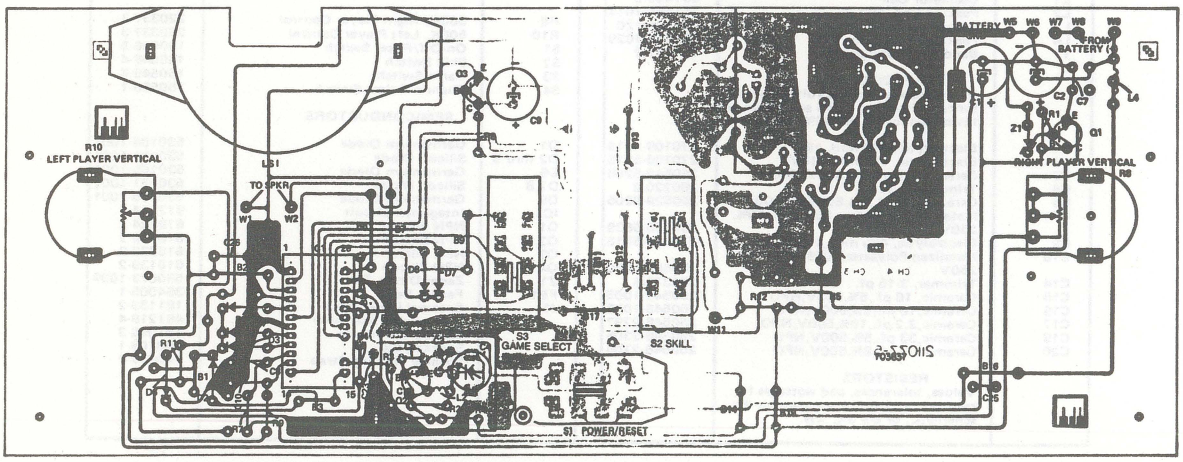



Fig. 3-15. Main PC board diagram of the BG7510.

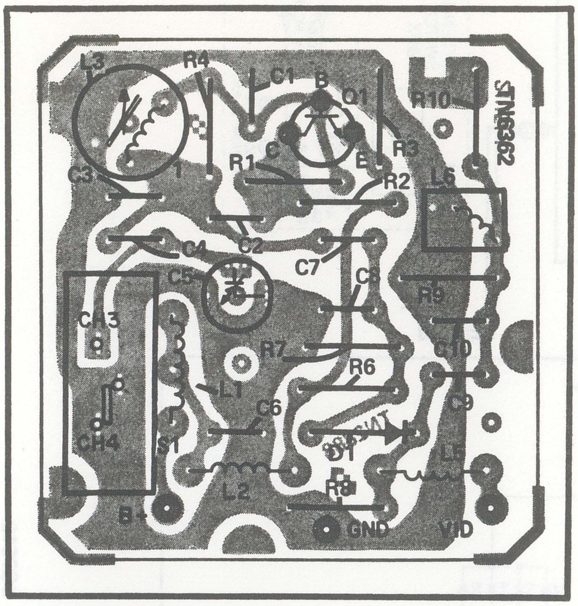



Fig. 3-16. RF modulator PC board of the BG7510.

three-position skill switch that enables the operator to change the player size by switching to the amateur, the professional, or the handicap position. In the handicap position, the right contestant will be handicapped with a player of smaller size than the left contestant.

Other features include automatic on-screen scoring (0 to 15), full color picture (when used with a color TV), and separate hand control units incorporating a joystick for random movement of the players on the screen. Each hand control unit is not directly attached to the main unit, but is connected through a cable, which lets the operator hold his hand control and gives him more freedom of movement (Fig. 3-21). The speed of the ball can be controlled by placing the ball speed switch in either the fast or the slow position.

When the ball speed switch is in the fast position, the ball will speed up on the seventh hit by a player (or players) after each point. In the slow position, the ball will stay slow at all times.

The BH7511 also incorporates sound and angle deflection of the ball. During play a separate audio tone is heard each time the ball hits a player, a barrier, or a point is scored. The angle at which the ball is deflected is determined by the point at which the ball hits a player. A ball passing through a player from the rear will also be deflected at an angle depending upon the point of entry through the player. When the ball hits a wall (barrier), the angle at which it deflects is determined by the angle at which it hits (Fig. 3-22).

Any game may be stopped and started over at any time on the BH7511 by moving the reset/on/off switch to the reset position. The unit also incorporates manual serve which is triggered by depressing one or both of the hand control action buttons (depending on the game being played).

## TYPICAL OPERATION

Connect the 300Ω twin lead from the antenna-game switch box to the 300Ω VHF antenna

| IC1 VOLTAGE CHART | | | | | |
|---|---|---|---|---|---|
| PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE |
| 1 | Not Used | ----- | 15 | Not Used | ----- |
| 2 | Ground | ----- | 16 | 5.8V | ----- |
| 3 | Sound | ----- | 17 | 4.4V | ----- |
| 4 | 6.4V | ----- | 18 | Not Used | ----- |
| 5 | Ground | ----- | 19 | Not Used | ----- |
| 6 | B. Video | ----- | 20 | 6.2V | 5 |
| 7 | 6.4V | 1 | 21 | 6.2V | 6 |
| 8 | Ground | ----- | 22 | 6.2V | 7 |
| 9 | R.P. Video | ----- | 23 | 6.2V | 8 |
| 10 | L.P. Video | ----- | 24 | W. Video | ----- |
| 11 | 1.2 to 5.4V | 2 | 25 | 6.2V | 9 |
| 12 | 1.2 to 5.4V | 3 | 26 | Ground | ----- |
| 13 | 6.2V | 4 | 27 | Sound | ----- |
| 14 | Not Used | ----- | 28 | Not Used | ----- |

Fig. 3-17. IC1 voltage chart for the BG7510.

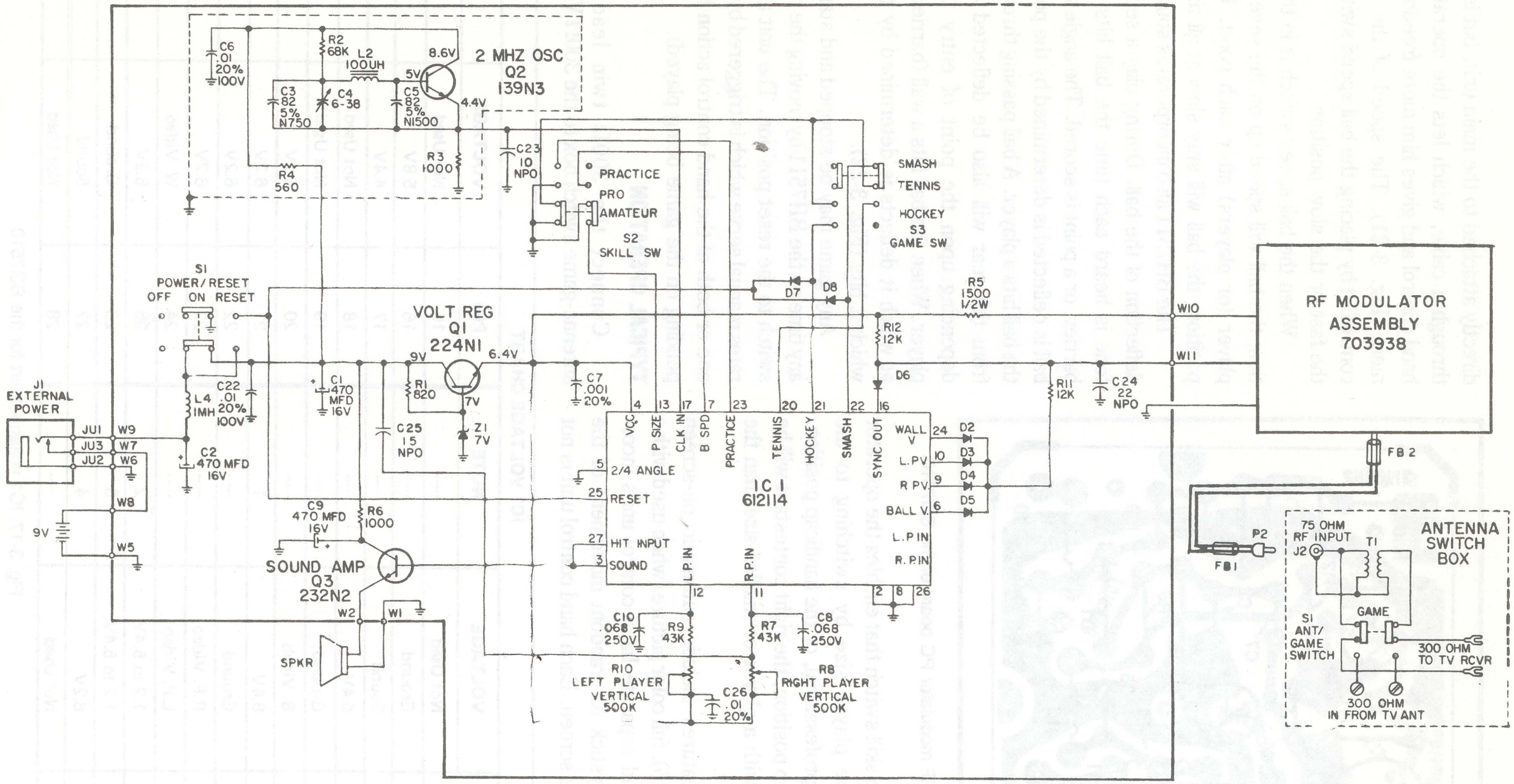



**Fig. 3-18. Schematic diagram of the game circuitry of the BG7510.**

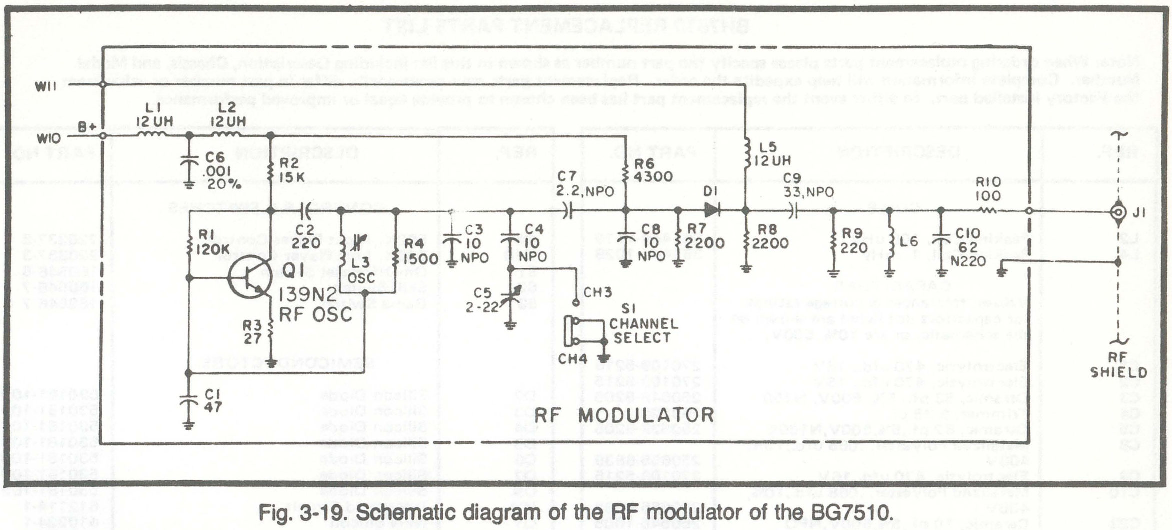



**Fig. 3-19. Schematic diagram of the RF modulator of the BG7510.**

terminals of a properly adjusted and operating television receiver. Connect the game cord cable from the Odyssey unit to the antenna-game switch box and place the game/TV switch in the game position.

Set the Odyssey channel select switch (located on the RF modulator box) to either channel 3 or 4. Turn the television VHF channel selector to the same channel. Plug the AC adapter into the adapter socket, located on the back of the Odyssey main unit, and apply power by moving the reset/on/off switch to the on position (fine tune the television if necessary). Slide the eight-position game switch to the tennis position. A tennis court should appear on the television screen. If viewed on a color set the background for tennis should be a light-green color (specific colors may vary depending upon the setting of the color, tint, contrast, and brightness controls of the television receiver). Adjust the player size by setting the skill switch to the desired level (professional, handicap, or amateur). The speed of the ball can be set by placing the ball speed switch in the fast or the slow position. In the slow position the ball moves at a moderate speed throughout the game. However, when the ball speed switch is placed in the fast position, the ball will speed up on the seventh hit by a player (or players) after each point is made.

When the Odyssey is first turned on, the score on the display may not show a 0-0 score. To begin the game (or to start over at any time during a game) with a score of 0-0, slide the reset/on/off switch to the reset position. This position is spring loaded so that the switch will return to the on position after the game display has been reset.

The score is now set to zero and the game is ready to begin. The contestant whose court the ball appears in serves. To serve, the contestant must push the action button located in the upper-left-hand corner of his hand control. The buttons are colored red for the left player and blue for the right player. In tennis a contestant gets five serves before passing service to his opponent. When the action button is pushed, the ball is served and the game begins. Located on each hand control is a joystick which allows the operator full control of his player's movement. The player will move on the screen in the same direction as the operator moves the joystick, providing the hand control is held with the colored action button in the upper-left-hand corner. During play, a separate audio sound is heard each time the ball hits a player, a barrier, or a point is scored. After five serves by one player, service is passed to the opponent and the ball automatically appears on his side of the court (at court's edge). Each time the ball leaves the playing area, the automatic scoring will award a point to the appropriate player. After either player has scored 15 points, the ball cannot be served until the reset/on/off switch is moved to reset to begin a new game.

## SERVICE ADJUSTMENT

Never perform any adjustment procedures until you are sure that the trouble is located in the video game itself. Even then the trouble may not be

## BH7510 REPLACEMENT PARTS LIST

**Note: When ordering replacement parts please specify the part number as shown in this list including Description, Chassis, and Model Number. Complete information will help expedite the order. Replacement parts may occasionally differ in part number or value from the Factory installed part. In either event the replacement part has been chosen to provide equal or improved performance.**

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | **COILS** | |
| L2 | Peaking Coil, 100 uHy | 361444-1015 |
| L4 | Peaking Coil, 1 mHy | 361444-1029 |
| | **CAPACITORS** | |
| | Values, tolerances & voltage ratings for capacitors not listed are shown on the schematic, or are 10%, 500V. | |
| C1 | Electrolytic, 470 ufd., 16V | 270109-5215 |
| C2 | Electrolytic, 470 ufd., 16V | 270109-5215 |
| C3 | Ceramic, 83 pf., 5%, 500V, N750 | 250549-8205 |
| C4 | Trimmer, 6-38 pf. | 260220-2 |
| C5 | Ceramic, 82 pf.,5%,500V,N1500 | 250529-8205 |
| C8 | Metalized Polyester, .068 ufd.,10%, 400V | 250655-6839 |
| C9 | Electrolytic, 470 ufd.,16V | 270109-5215 |
| C10 | Metalized Polyester, .068 ufd.,10%, 400V | 250655-6839 |
| C23 | Ceramic, 10 pf.,5%,500V,NPO | 250546-1005 |
| C24 | Ceramic, 22 pf.,10%,500V,NPO | 250546-2209 |
| C25 | Ceramic, 1.5 pf., ±.1 pf.,500V,NPO | 250546-1596 |
| | **RESISTORS** | |
| | Values, tolerances & wattages for resistors not listed are shown on the schematic, or are 5%, ¼W. | |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | **CONTROLS & SWITCHES** | |
| R8 | 500K, Right Player Control | 220337-3 |
| R10 | 500K, Left Player Control | 220337-3 |
| S1 | On-Off/Reset Switch | 160546-5 |
| S2 | Skill Switch | 160546-7 |
| S3 | Game Switch | 160546-7 |
| | **SEMICONDUCTORS** | |
| D2 | Silicon Diode | 530181-1001 |
| D3 | Silicon Diode | 530181-1001 |
| D4 | Silicon Diode | 530181-1001 |
| D5 | Silicon Diode | 530181-1001 |
| D6 | Silicon Diode | 530181-1001 |
| D7 | Silicon Diode | 530181-1001 |
| D8 | Silicon Diode | 530181-1001 |
| IC1 | Integrated Circuit | 612114-1 |
| Q1 | NPN Silicon | 610224-1 |
| Q2 | NPN Silicon | 610139-3 |
| Q3 | NPN Silicon | 610232-2 |
| Z1 | Zener Diode | 530073-1039 |
| J1 | External Power Jack | 181139-2 |
| | Speaker 2¼" | 580108-1 |
| | Speaker Holding Strap | 143856-1 |
| | Battery Connector | 181096-3 |

## RF MODULATOR REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | **COILS** | |
| L1 | Peaking Coil, 12 uHy | 361425-120 |
| L2 | Peaking Coil, 12 uHy | 361425-120 |
| L3 | Oscillator Coil | 361398-21 |
| L5 | Peaking Coil, 12 uHy | 361425-120 |
| L6 | Filtering Coil | 361558-4 |
| | **CAPACITORS** | |
| | Values, tolerances & voltage ratings for capacitors not listed are shown on schematic, or are 10%, 500V. | |
| C3 | Ceramic, 10 pf.,5%,500V, NPO | 250546-1005 |
| C4 | Ceramic, 10 pf.,5%,500V,NPO | 250546-1005 |
| C5 | Trimmer, 2-22 pf.,100V | 260220-5 |
| C7 | Ceramic, 2.2 pf., ±.25, 500V,NPO | 250546-2297 |
| C8 | Ceramic, 10 pf.,5%,500V,NPO | 250546-1005 |
| C9 | Ceramic, 33 pf.,5%,500V,NPO | 250546-3305 |
| C10 | Ceramic, 62 pf.,5%,500V,N220 | 250666-6205 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | **RESISTORS** | |
| | Values, tolerances, & wattages for resistors not listed are shown on the schematic, or are 5%, ¼W. | |
| | **SWITCHES** | |
| S1 | Channel Select Switch | 160556-2 |
| | **SEMICONDUCTORS** | |
| D1 | Germanium Diode | 530105-1001 |
| Q1 | NPN Transistor | 610139-2 |
| | **MISCELLANEOUS** | |
| | RF Module Top Cover | 733293-3 |
| | RF Module Bottom Cover | 733293-5 |
| J1 | RF Output Jack | 181095-4 |
| | RF Cable Assembly | 461218-6 |
| | –Coax Plug | 180903-1 |
| | Complete RF Module Assembly | 703938-2 |

## CABINET REPLACEMENT PARTS LIST

| DESCRIPTION | PART NO. |
|---|---|
| Cabinet Top | 143670-7 |
| Cabinet Bottom | 143669-5 |
| Bezel Control (Visiting Team) | 143854-2 |
| Bezel Control (Home Team) | 143854-1 |
| Inlay, Visiting Team | 151484-3 |
| Inlay, Home Team | 151484-4 |
| Inlay, Center | 151483-5 |
| Knob, Black (2 used) | 142695-5 |
| Dust Barrier f/Game Switch | 151449-3 |
| Dust Barrier f/Power Switch | 151449-5 |
| Dust Barrier f/Skill Switch | 151449-3 |
| Battery Holder | 142658-1 |
| Foot, Black (4 used) | 141737-3 |
| Push Nut Fastener (4 used) | 103126-14 |
| Spring Lock Nut | 103235-1 |
| "O" Ring f/Stud | 103082-4 |
| Fastener Stud | 732953-2 |

## ANTENNA/GAME SWITCH REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| T1 | Antenna Balun | 361108-2 |
| S1 | Antenna Game Switch | 160499-3 |
| | Antenna Screw Terminal (2 used) | 200495-1 |
| | Solderless Terminal (2 used) | 200517-1 |
| J2 | RF Input Socket | 180902-4 |
| | Twin Lead Cable Assembly | 782237-2 |
| | Antenna Case Front | 143676-1 |
| | Antenna Case Back | 143674-1 |
| | Plastic Hook | 143719-1 |
| | Complete Antenna/Game Sw. Assembly | 701702-6 |

Fig. 3-20. Parts list for the BG7510.

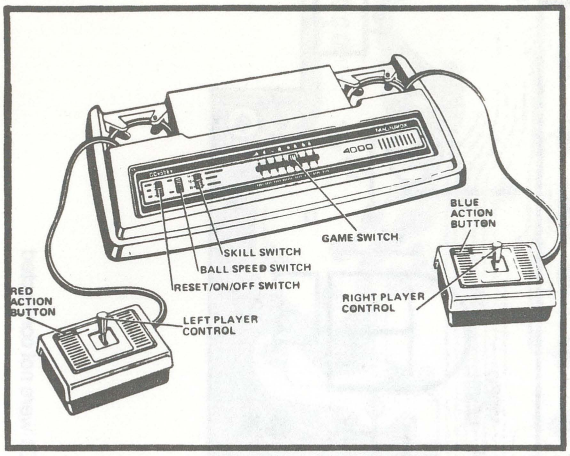



Fig. 3-21. Control functions of the BG7511.

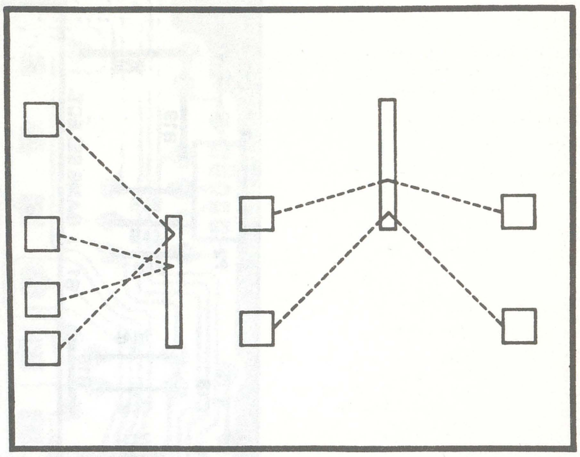


Fig. 3-22. Angles of deflection of the ball when striking a wall or player.

corrected by an adjustment. It is better by far to determine the actual nature or fault before jumping to a conclusion about how to correct a malfunction. Random try-and-see procedures usually result in compounded troubles.

When you are sure that the defect can be corrected by one of the following procedures, read over the steps first to be sure that you have all of the equipment and tools on hand. Refer to Figs. 3-23 and 3-24 for the location of test points, adjustments, and components outlined in the following procedures. Use nonmetallic tuning tools for all adjustments.

### 3.58 MHz Clock

1. Connect a high-impedance frequency counter to pin 6 of IC2.
2. Adjust trimmer capacitor C10 for a clock frequency of 3.579545 MHz ±50 Hz. When the frequency counter is connected to pin 6, distortion on the TV screen may result; however, pin 6 is a buffered output and the reading on the counter will be unaffected.

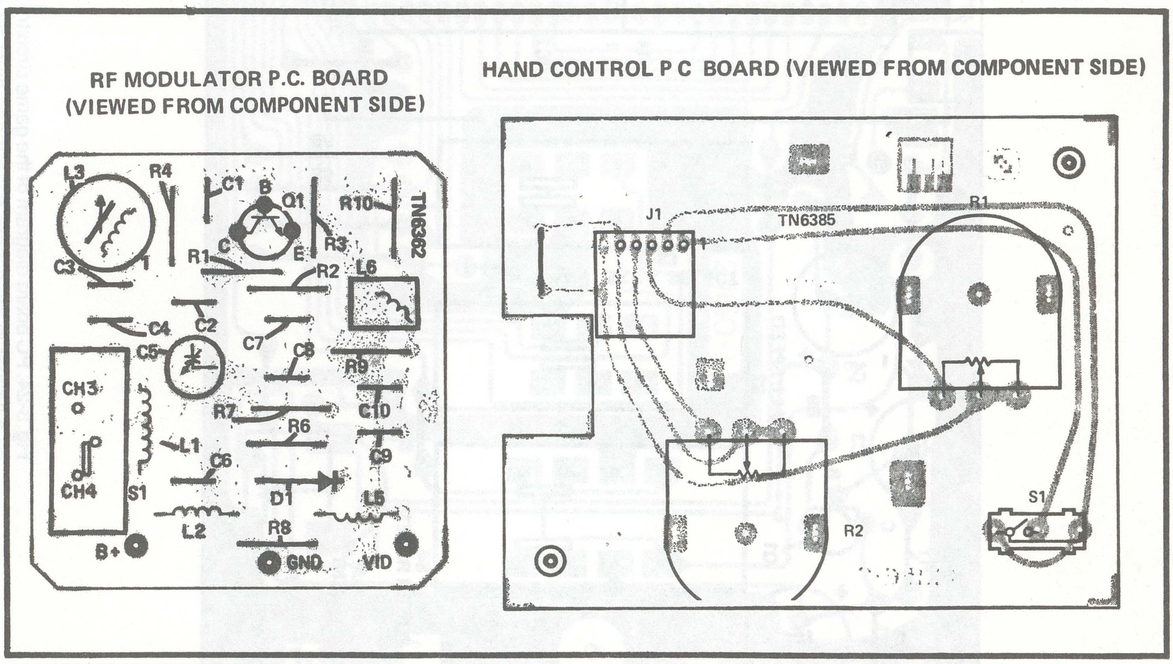



Fig. 3-23. PC board diagrams of the RF modulator subassembly and a hand control unit for the BG7511. Although not shown, capacitor C11 is connected in series with resistor R10 on the modulator board.

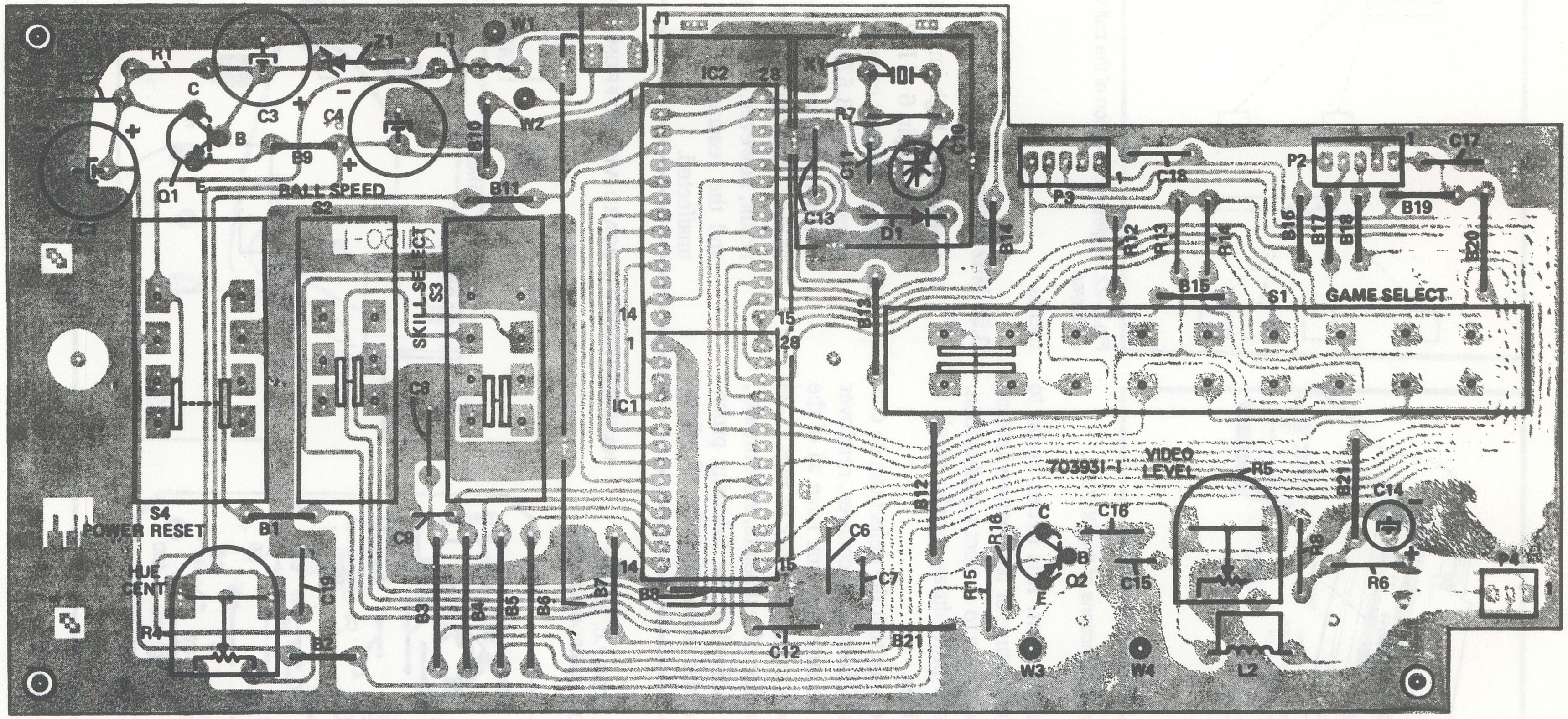



Fig. 3-24. PC board diagram of the game circuitry in the BG7511. In early productions, pins 3 and 4 of IC1 were not connected by a jumper in the copper pattern and must be connected by a solder bridge.

### Channel 3 & 4 RF Oscillator

1. Connect the Odyssey to an operating TV and defeat the television AFT.
2. Turn the TV channel selector to channel 3 and set the Odyssey channel select switch (located on the RF modulator assembly) to channel 3 also.
3. While observing the game display, adjust coil L3 for optimum response.
4. Switch the TV and the Odyssey to channel 4.
5. While observing the game display, adjust trimmer capacitor C5 for optimum response on the TV screen.
6. Repeat steps 2 through 5 until channel 3 and 4 game displays are equal in quality.

### Video Level

1. Connect an oscilloscope to the wiper arm of video level control R5.
2. Adjust the video signal for a nominal voltage of 0.8V P-P.

### Hue Control

The hue control adjustment should be made only after the *3.58 MHz Clock* and *Video Level* adjustments have been made.

1. Before adjusting the hue control, tune the TV to a local station. Adjust the controls for a good color picture.
2. Connect the Odyssey to the TV and slide the eight-position game switch to the tennis position.

**IC1 VOLTAGE CHART**

| PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE |
|---|---|---|---|---|---|
| 1 | Ground | ----- | 15 | 1.7V - 4.7V | 6 |
| 2 | 5.7V | ----- | 16 | 6.2V | ----- |
| 3 | 5.3V | ----- | 17 | 6.2V | 7 |
| 4 | 5.3V | ----- | 18 | 6.2V | 8 |
| 5 | 1.6V | ----- | 19 | 6.2V | 9 |
| 6 | 5.9V | ----- | 20 | 6.2V | 10 |
| 7 | 6.1V | ----- | 21 | 6.2V | 11 |
| 8 | 6.1V | ----- | 22 | NC | ----- |
| 9 | 1.3V | ----- | 23 | 6.1V | ----- |
| 10 | 6.1V | 1 | 24 | 6.1V | ----- |
| 11 | 1.7V - 4.7V | 2 | 25 | 6.1V | ----- |
| 12 | 6.2V | 3 | 26 | 6.2V | ----- |
| 13 | Sound Out | 4 | 27 | 6.2V | ----- |
| 14 | 6.1V | 5 | 28 | 6.2V | ----- |

**IC2 VOLTAGE CHART**

| PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE |
|---|---|---|---|---|---|
| 1 | Ground | ----- | 15 | 6.1V | ----- |
| 2 | 1.5V | ----- | 16 | 6.1V | ----- |
| 3 | VAR. CAP | ----- | 17 | 6.1V | ----- |
| 4 | 0V - 6.2V | 12 | 18 | 6.1V | ----- |
| 5 | 1.3V | 13 | 19 | 6.1V | ----- |
| 6 | 1.3V | ----- | 20 | 6.1V | ----- |
| 7 | 6.1V | ----- | 21 | 6.2V | ----- |
| 8 | 6.1V | ----- | 22 | 6.2V | ----- |
| 9 | 5.9V | ----- | 23 | NC | ----- |
| 10 | 1.6V | 14 | 24 | NC | ----- |
| 11 | 5.3V | ----- | 25 | NC | ----- |
| 12 | 6.3V | ----- | 26 | NC | ----- |
| 13 | 5.7V | ----- | 27 | NC | ----- |
| 14 | NC | ----- | 28 | NC | ----- |

Fig. 3-25. Voltage charts for IC1 and IC2.

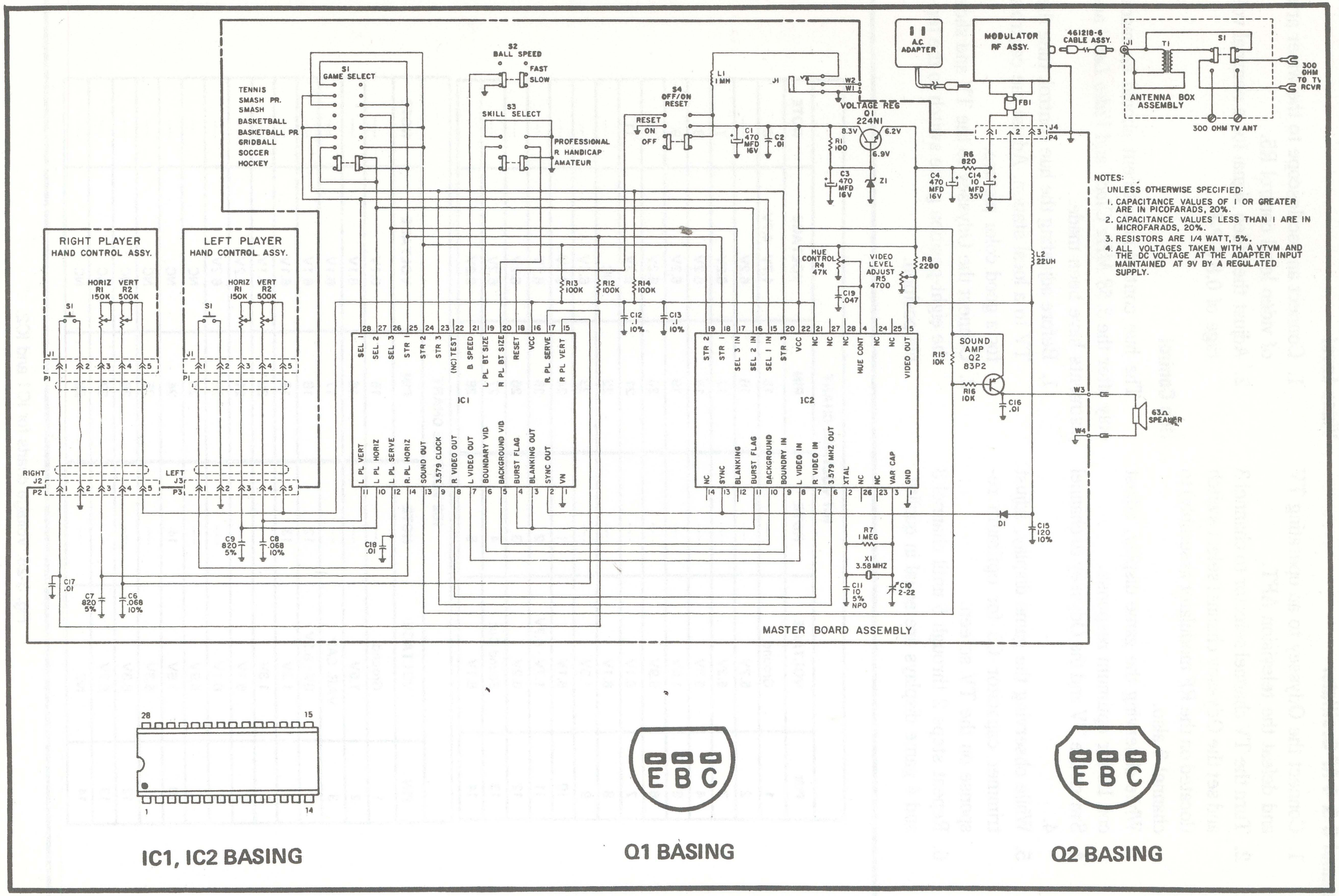



Fig. 3-26. Schematic diagram of the BG7511

3. Adjust hue control R4 to obtain a green background color with yellow-to-orange field lines.
4. Cycle through the remaining seven games and check for the existence of color on each game. There should be four distinct background colors as follows:

| Game | Background |
|---|---|
| Tennis & Soccer | Green |
| Hockey & Gridball | Blue |
| Basketball Practice & Smash Practice | Cyan |
| Basketball & Smash | Magenta |

**NOTE**

The colors may vary depending upon the control settings of the television receiver.

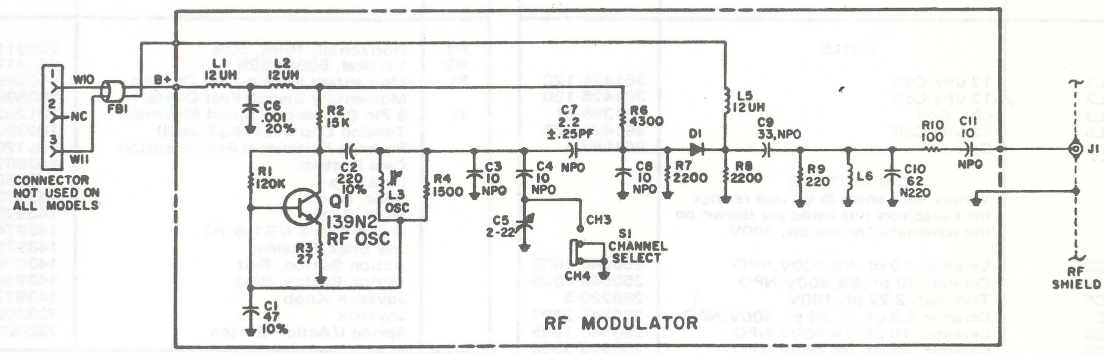
## TROUBLESHOOTING

As it should be with any troubleshooting procedure, isolating the defect to a small circuit area is the first step. Then, using a logical method of deduction, the probable trouble area can be reduced to an even smaller area, step by step, until the malfunctioning component has been located. In the case of video games, this task should not be too difficult, considering the simplicity of circuitry.

Although at first glance, the typical video game may seem to be an electronic wonder, its operation as interacting stages is simple when considering the game clip as a single entity. In the circuitry of the BH7511 there are two hand controls, a game clip, a color chip, an RF modulator, an antenna box assembly, a sound amplifier, and a voltage regulator. Of these eight major circuit areas, the two chip circuits encompass most of the electronics.

Needless to say, troubleshooting the two chip circuits will produce the greatest difficulty for the average technician. To aid you in this task, voltage charts for both ICs are provided in Fig. 3-25. Each time a reading is taken refer to the note references and their explanations given in the lower portion of the figure.

The overall schematic diagram for the BH7511 video game is shown in Fig. 3-26. You'll notice that the RF modulator subassembly is shown as a "black box." A detailed schematic of the RF modulator is shown in Fig. 3-27. Replacement parts are shown in Fig. 3-28.




**NOTES:**
**UNLESS OTHERWISE SPECIFIED:**
1. CAPACITANCE VALUES OF ONE OR GREATER ARE IN PICOFARADS, 5%.
2. CAPACITANCE VALUES LESS THAN ONE ARE IN MICROFARADS, 5%.
3. RESISTORS ARE 1/4 WATT, 5% TOLERANCE.

Fig. 3-27. Schematic diagram of the RF modulator in the BG7511.

## BH7511 REPLACEMENT PARTS LIST

**Note: When ordering replacement parts please specify the part number as shown in this list including Description, Chassis, and Model Number. Complete information will help expedite the order. Replacement parts may occasionally differ in part number or value from the Factory installed part. In either event the replacement part has been chosen to provide equal or improved performance.**

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | COILS | |
| L1 | 1 mhy Coil | 361444-1029 |
| L2 | 22 uhy Coil | 361425-220 |
| | CAPACITORS | |
| C1 | Electrolytic, 470 mfd., 16V | 270144-5215 |
| C3 | Electrolytic, 470 mfd., 16V | 270144-5215 |
| C4 | Electrolytic, 470 mfd.,16V | 270144-5215 |
| C6 | Metalized Polyester, .068 mfd.,10%, 250V | 250655-6839 |
| C8 | Metalized Polyester, .068 mfd.,10%, 250V | 250655-6839 |
| C10 | Trimmer, 2-22 pf.,100V | 260220-5 |
| C11 | Ceramic, 10 pf.,5%,500V,NPO | 250546-1005 |
| C12 | Metalized Polyester, 0.1 mfd.,10%, 100V | 250654-1049 |
| C13 | Metalized Polyester, 0.1 mfd.,10%, 100V | 250654-1049 |
| C14 | Electrolytic, 10 mfd., 35V | 270109-1135 |
| C19 | Metalized Polyester, .047 mfd.,20%, 250V | 250655-4730 |
| | CONTROLS & SWITCHES | |
| R4 | Hue Control, 47K, 30% | 220300-4733 |
| R5 | Video Level, 4.7K, 30% | 220300-4723 |
| S1 | 8 Position Slide Switch (Game Select) | 160592-1 |
| S2 | Slide Switch (Ball Speed) | 160546-3 |
| S3 | Slide Switch (Skill Select) | 160546-7 |
| S4 | Slide Switch (On/Off/Reset) | 160546-5 |
| | SEMICONDUCTORS | |
| D1 | Germanium Diode | 530065-1002 |
| Z1 | Zener Diode | 530073-1039 |

| REF | DESCRIPTION | PART NO. |
|---|---|---|
| Q1 | NPN Silicon Transistor | 610224-1 |
| Q2 | PNP Silicon Transistor | 610083-2 |
| IC1 | Master Game IC | 612146-1 |
| IC2 | Color Converter IC | 612156-1 |
| | MISCELLANEOUS | |
| J1 | Adapter Jack | 181139-4 |
| P2 | 5 Pin Connector (Board Mounted) | 181253-5 |
| P3 | 5 Pin Connector (Board Mounted) | 181253-5 |
| P4 | 3 Pin Connector (Board Mounted) | 181253-3 |
| X1 | 3.58 MHz Crystal | 560404-2 |
| | IC Shield (Top Cover) | 733393-1 |
| | Crystal Circuitry Shield (Top Cover) | 733392-1 |
| | Shield (Bottom Cover) | 733394-1 |
| | RF Modulator Assembly | 703938-1 |
| | Antenna Switch Box Assembly | 701702-5 |
| | Solderless Terminal (2 used-Speaker Wires) | 102487-30 |
| | Speaker Clip (2 used-Speaker Mtg.) | 102393-90 |
| | "O" Ring Retainer f/Stud | 103082-4 |
| | Speaker, 2¼", 63 ohm | 580108-2 |
| | Ground Strap-RF Modulator (2 used) | 200401-20 |
| | Game Select Knob | 143982-1 |
| | Spring Lock Nut f/Stud | 103235-1 |
| | Foot (Black-4 used) | 141737-3 |
| | Case Bottom | 143669-7 |
| | Case Top | 143962-1 |
| | Inlay | 151603-1 |
| | RF Cable Assembly | 461218-6 |
| | Coax Plug (RF Cable) | 181235-9 |
| | Cable Assembly-Hand Control (Includes Connectors) | 702597-1 |
| | 5 Pin Molex Connector (Hand Control Cable) | 181252-5 |
| | Stud, Cover Holding | 732953-2 |
| | AC Adaptor | AG9004-BK01 |

## RF MODULATOR REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | COILS | |
| L1 | 12 uhy Coil | 361425-120 |
| L2 | 12 uhy Coil | 361425-120 |
| L3 | Osc. Coil | 361398-21 |
| L5 | 12 uhy Coil | 361425-120 |
| L6 | Coil | 361558-4 |
| | CAPACITORS<br>Values, tolerances & voltage ratings for capacitors not listed are shown on the schematic, or are 5%, 500V. | |
| C3 | Ceramic, 10 pf.,5%,500V,NPO | 250546-1005 |
| C4 | Ceramic,10 pf.,5%,500V,NPO | 250546-1005 |
| C5 | Trimmer, 2-22 pf.,100V | 260220-5 |
| C7 | Ceramic,2.2 pf., ±.25 pf.,500V,NPO | 250546-2297 |
| C8 | Ceramic, 10 pf.,5%,500V,NPO | 250546-1005 |
| C9 | Ceramic, 33 pf.,5%,500V,NPO | 250546-3305 |
| C10 | Ceramic, 62 pf.,5%,500V,N220 | 250666-6205 |
| C11 | Ceramic,10 pf.,5%,500V,NPO | 250546-1005 |
| | SWITCHES | |
| S1 | Slide Switch (Channel Select) | 160556-2 |
| | SEMICONDUCTORS | |
| D1 | Silicon Diode | 530181-1001 |
| Q1 | NPN Silicon Transistor | 610139-2 |
| | MISCELLANEOUS | |
| J4 | 3 Pin Molex Connector | 181252-3 |
| FB1 | Ferrite Bead | 364005-1 |
| | RF Modulator (Top Cover-Copper Bd. Side) | 733293-1 |
| | RF Modulator (Bottom Cover-Channel Switch Side) | 733293-4 |
| | RF Output Jack | 181095-4 |

## HAND CONTROL REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| R1 | Horizontal, 150K, 20% | 220311-16 |
| R2 | Vertical, 500K, 20% | 220311-15 |
| S1 | Momentary Switch-Leaf Contact | 160599-2 |
| | Momentary Switch-Post Contact | 160599-1 |
| J1 | 5 Pin Connector (Board Mounted) | 181253-5 |
| | Tension Clip f/Crank (2 used) | 102393-92 |
| | Pushnut Fastener f/Action Button | 103126-12 |
| | Case Bottom | 143967-1 |
| | Case Top | 143968-2 |
| | Slide, Black | 143973-2 |
| | Slide, Beige | 143973-1 |
| | Nylon Crank f/R1 & R2 | 143974-3 |
| | Joy Stick Retainer | 143975-1 |
| | Action Button, Red | 143976-2 |
| | Action Button, Blue | 143976-1 |
| | Joystick Knob | 143977-2 |
| | Joystick | 733300-3 |
| | Spring f/Action Button | 733305-1 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| T1 | Antenna Balun | 361108-2 |
| S1 | Slide Switch (Antenna/Game) | 160499-3 |
| J1 | RF Input Socket | 180902-4 |
| | Screw Terminal (2 used) | 200495-1 |
| | Solderless Terminal (2 used) | 200517-1 |
| | Case, Bottom | 143674-1 |
| | Case, Top | 143676-1 |
| | Plastic Hook | 143719-1 |
| | Complete Antenna/Game Switch Assembly | 701702-5 |

Fig. 3-28. Parts list for the BG7511.

## ODYSSEY MODEL BH7514

The BH7514 can be powered by either 6 C-cells or an optional AC-to-DC voltage adapter. It features games of tennis, hockey, smash, and practice, with skill levels from amateur to professional using ball speed, ball angle, and player size for the more demanding enthusiast. Serving can be either manual, by depressing the serve button or automatic. Automatic features include on-screen scoring, which awards a point to the appropriate player or team each time the ball leaves the playing area. Automatic serve will return the ball into play from the side that was awarded the point. This sequence will be repeated until a score of 15 is reached by one side, after which the ball will continue to bounce around with no further hits or scores. Depressing reset will change the score to indicate 0-0, and the ball will be served randomly from the left or right side.

During play three audio tones will be generated to indicate that the ball has touched the top or bottom walls, the player has hit the ball, or that a score has been made.

### TYPICAL OPERATION

Connect the 300Ω twin lead of the antenna/game switch to the VHF antenna terminals of a properly operating television. Connect the VHF antenna wires (if used) to the antenna/game switch terminals. When changing from game to television, make sure that the slide switch is moved to the extreme position; do not leave the slide switch in the midposition. Plug the game cord from the Odyssey into the antenna/game switch socket and place the slide switch to the game position. Place the channel switch, located in the battery compartment, in either the channel 3 or channel 4 position. The channel switch is for selection of the unused channel of VHF in your area.

Set the game selector to a position so that the double arrow is indicating your choice of games by name and picture. Turn the television and Odyssey on. Push the reset switch so that the score and ball will be in the starting position. Fine tune the television if necessary. Select the desired ball serve, ball speed, ball angle, and player size modes via the front-panel switches. The Odyssey is now ready for the game to begin. Control of the players is accomplished by rotating the player controls, which are detachable. When either contestant reaches 15 points there will be no control of the ball and a new game will have to be started.

### SERVICE ADJUSTMENTS

Never perform any of the following service procedures until you are sure that fault lies in the video game itself. Check its operation by hooking it to a properly operating TV receiver. When you are sure that the trouble lies within the video game and that one of the following procedures cures the malfunction, read over the steps of the procedure first to ensure that you have the required test equipment on hand. Refer to Figs. 3-29 and 3-30 for the location of test points, adjustments, and components outlined in the procedures. Use nonmetallic tuning tools for all adjustments.

#### 2 MHz Oscillator

1. Connect a frequency counter in series with a 10K resistor and a 0.01 $\mu$F capacitor to pin 17 of chip U1.
2. Adjust the core of coil L1 for 2.01 MHz ±20 kHz.

#### RF Oscillator

1. Connect the Odyssey to an operating TV and defeat the TV's AFT.
2. Place the TV channel selector to channel 3, mechanically center the fine tuning, and set the Odyssey channel selector switch to channel 3.
3. While observing the game display, adjust trimmer capacitor CT1 for the best response of the picture. Channel 4 operation is not adjustable.

### TROUBLESHOOTING

Begin your troubleshooting by isolating the defect to as small an area as possible. That is, cut down the possibilities to only the components that could cause the malfunction. A systematic approach will help this process immensely. Examining the composition of the circuitry should be the first step.

Looking at the overall schematic diagram in Fig. 3-31, you can readily see that the BH7514 is

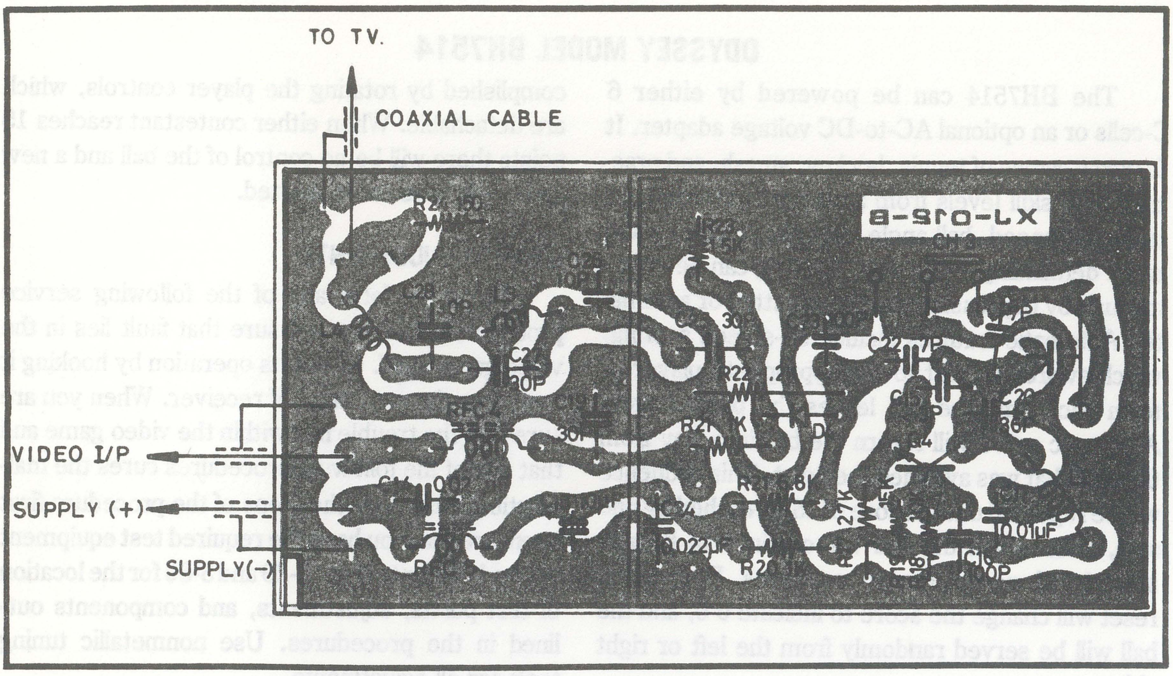



Fig. 3-29. PC board diagram for the RF modulator in the BG7514.

composed of game chip U1, voltage regulator Q1, sound amplifier Q2, 2 MHz oscillator Q3, and the RF modulator subassembly. The RF modulator subassembly contains two active components: RF oscillator Q4 and mixer diode D4.

It will depend on the exact symptom as to just how you should begin the isolating process. A symptom of *no display* could be caused by a malfunction in the game board or RF modulator. The first thing to do in this case is to check the supply voltage, be it batteries or AC adapter. A good place to check this would be a power on/off switch S8. If this is within limits move to the emitter of voltage regulator Q1. The proper voltage for the emitter, collector, and base of Q1 is shown on the schematic. As indicated in note 4, these voltages were taken with the AC adapter connected to external power jack J1 by using a VTVM. Any high-impedance voltmeter will do. If the trouble doesn't seem to be in the power supply move on to specific stages.

The next place to look is the RF modulator, because with it not operating there will be no RF carrier for the video information to be impressed on. One way to check the RF is to construct your own RF modulator using a signal generator and mixer pad. Mixer pads are used in TV alignment procedures for injecting crystal markers. Couple the output of the game board to one input of the mixer pad, and feed the other input with an RF signal from your generator. Don't modulate the output of the generator with anything but the video from the game board. If a display appears on the screen you can safely say that there is trouble somewhere between the output of the game board and the input of the TV.

Another way to determine if the RF modulator is at fault or if the game board is defective is to couple the output of the game board to the input of a video amplifier in a properly operating TV receiver through a blocking capacitor. Of course, it might show up as negative video, depending on the stage that the signal is injected into.

Once you've isolated the trouble down to the game board or the RF modulator, it is a simple matter of checking voltages, etc., to determine the defective component. Voltages for game chip U1 are shown in Fig. 3-32. Referring to this chart when the chip is suspected will help confirm any doubts about the condition of the chip. Beware though—read the notes next to each entry before condemning the chip.

After it has been determined what component is defective, refer to the parts list shown in Fig. 3-33 to obtain the correct replacement part number.

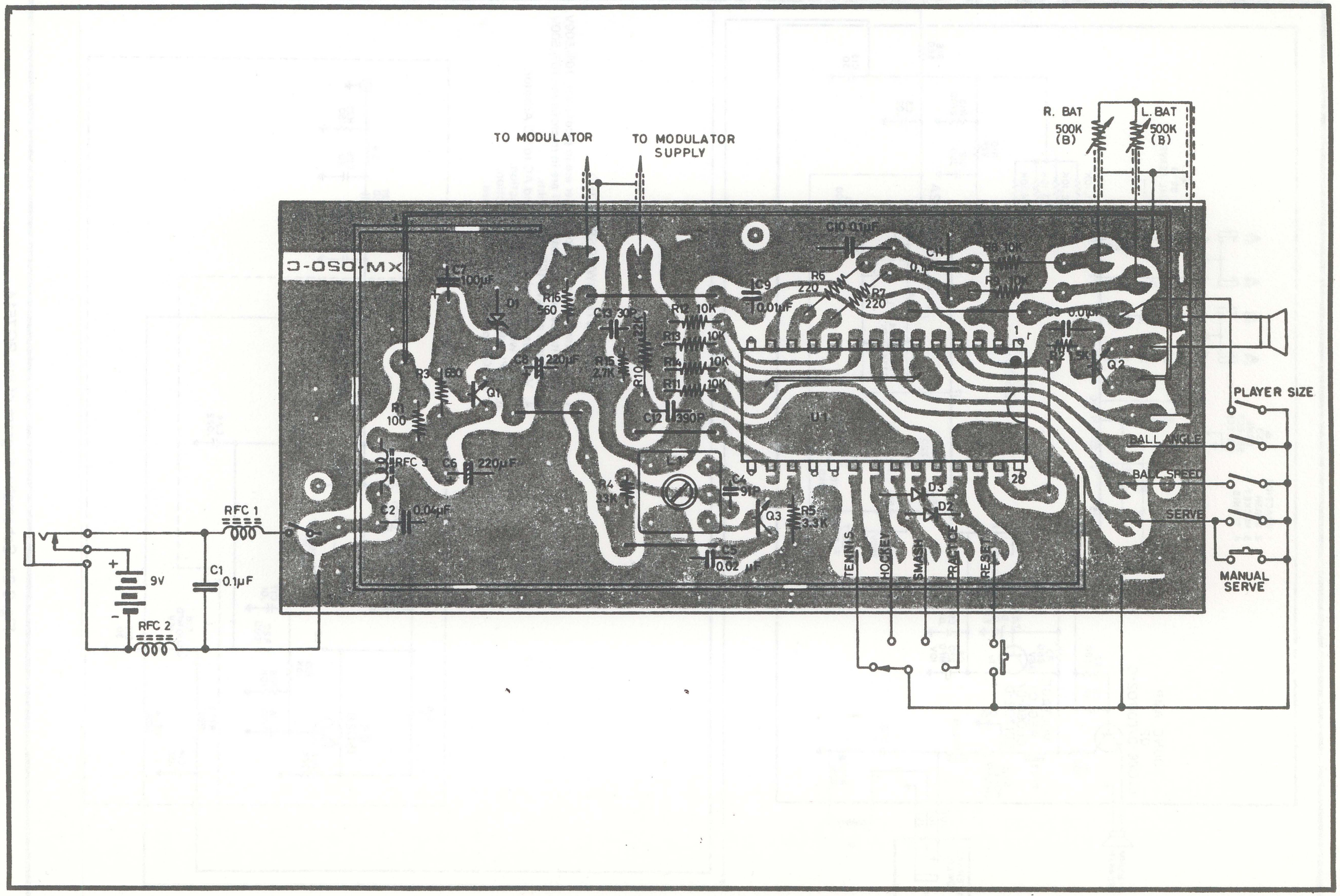



Fig. 3-30. Main PC board diagram of the BG7514.

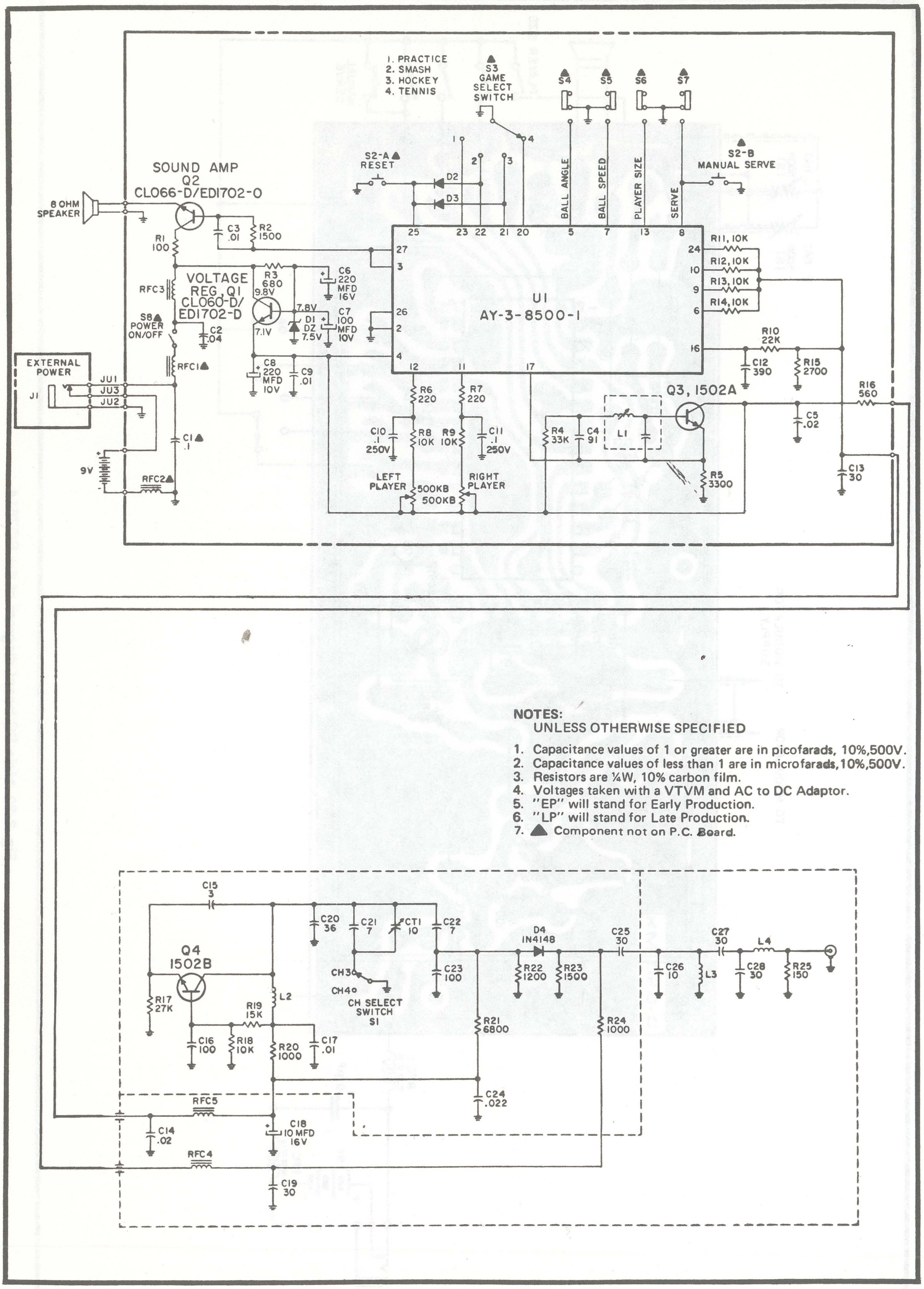



Fig. 3-31. Schematic diagram of the BG7514.

| Pin | Selection | Notes | Pin | Selection | Notes |
|---|---|---|---|---|---|
| 1 | ----- | Not Used | 15 | ----- | Not Used |
| 2 | 0.00V | Ground | 16 | 5.45V | Sync Output |
| 3 | Pulse | Sound | 17 | 5.00V | Clock Input |
| 4 | 7.13V | VCC | 18 | 6.85V | Not Used |
| 5 | 6.95V/0.00V | Amateur/Professional (Ball Angle) | 19 | 6.85V | Not Used |
| 6 | ----- | Video (Ball Output) | 20 | 6.85V/0.00V | Not Selected/Selected (Tennis) |
| 7 | 6.93V/0.00V | Amateur/Professional (Ball Speed) | 21 | 6.85V/0.00V | Not Selected/Selected (Hockey) |
| 8 | 6.91V/0.00V | Manual/Auto (Serve) | 22 | 6.85V/0.00V | Not Selected/Selected (Smash) |
| 9 | ----- | Video (Right Player Output) | 23 | 6.85/0.00V | Not Selected/Selected (Practice) |
| 10 | ----- | Video (Left Player Output) | 24 | ----- | Video (Score and Field Output) |
| 11 | 1.00V to 6.62V | Varies (Right Bat Input) | 25 | 6.92V/0.00V | Open/Closed (Reset) |
| 12 | 1.00V to 6.62V | Varies (Left Bat Input) | 26 | 0.00V | Ground |
| 13 | 6.90V/0.00V | Amateur/Professional (Bat Size) | 27 | Pulse | Sound |
| 14 | ----- | Not Used | 28 | ----- | Not Used |

U1 VOLTAGE CHART

Fig. 3-32. Voltage chart for game chip U1 of the BG7514.

## BH7514 REPLACEMENT PARTS LIST

**Note: When ordering replacement parts please specify the part number as shown in this list including Description, Chassis, and Model Number. Complete information will help expedite the order. Replacement parts may occasionally differ in part number or value from the Factory installed part. In either event the replacement part has been chosen to provide equal or improved performance.**

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | COILS | |
| RFC1 | Coil, 82 uh | 36Q001-1 |
| RFC2 | Coil, 82 uh | 36Q001-1 |
| RFC3 | Coil, 82 uh | 36Q001-1 |
| RFC4 | Coil, 82 uh | 36Q001-1 |
| RFC5 | Coil, 82 uh | 36Q001-1 |
| L1 | Oscillator Coil, 2 MHz | 36Q001-2 |
| L2 | VHF Coil | 36Q001-3 |
| L3 | Filter Coil | 36Q001-4 |
| L4 | Filter Coil | 36Q001-4 |
| | CAPACITORS<br>Values, tolerances & voltage ratings for capacitors not listed are shown on the schematic, or are 10%, 25V. | |
| CT1 | Trimmer, 0-10 pf. | 26Q001-1 |
| C1 | Ceramic, .1 mfd., +80/-20%, 25V | 25X008-1047 |
| C2 | Ceramic, .04 uf., +80/-20%, 25V | 25X007-4037 |
| C3 | Ceramic, .01 uf., +80/-20, 25V | 25X005-1037 |
| C5 | Ceramic, .022 uf., +80/-20%, 25V | 25X005-2237 |
| C5 | Ceramic, .02 uf., +80/-20%, 25V | 25X005-2037 |
| C6 | Electrolytic, 220 uf., 16V | 27X109-2215 |
| C7 | Electrolytic, 100 uf., 10V | 27X109-1210 |
| C8 | Electrolytic, 220 uf., 10V | 27X109-1210 |
| C9 | Ceramic, .01 uf., +80/-20%, 25V | 25X005-1037 |
| C14 | Ceramic, .02 uf., +80/-20%, 25V | 25X005-2037 |
| C15 | Ceramic, 3 pf., ± 0.5 pf., 25V | 25X005-3091 |
| C17 | Ceramic, .01 uf., +80/-20%, 25V | 25X005-1037 |
| C18 | Electrolytic, 10 uf., 25V | 27X109-1010 |
| C20 | Temp. Comp., 36 pf., ± 10%, NPO | 25X021-3609 |
| C21 | Ceramic, 7 pf., ± 0.5 pf., 25V | 25X005-7091 |
| C22 | Ceramic, 7 pf., ± 0.5 pf., 25V | 25X005-7091 |
| C24 | Ceramic, .022 uf., +80/-20%, 25V | 25X005-2237 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | RESISTORS<br>Values, tolerance & wattages for resistors not listed are shown on the schematic, or are 5%, ¼W. | |
| | CONTROLS & SWITCHES | |
| | 500 KB Player Control | 22Q001-1 |
| S1 | Channel Select Switch | 16Q001-1 |
| S2-A/B | Manual Serve-Reset Switch Ass'y. | 70Q001-1 |
| S3 | Game Selector Switch | 16Q001-4 |
| S4 | Ball Angle Switch | 16Q001-2 |
| S5 | Ball Speed Switch | 16Q001-2 |
| S6 | Player Size Switch | 16Q001-2 |
| S7 | Serve Switch | 16Q001-2 |
| S8 | Power Switch | 16Q001-3 |
| | SEMICONDUCTORS | |
| D1 | Zener Diode, 7.5V | 53Q001-1 |
| D2,3,4 | Silicon Diode | 53W001-7 |
| Q1,2 | NPN Silicon | ED1702-0 |
| Q3 | NPN Silicon | 1502A |
| Q4 | NPN Silicon | 1502B |
| J1 | External Power Jack | 18Q001-1 |
| U1 | Game Chip (VHF) | 612114-1 |
| | Game Cord, 75 ohm, Coaxial w/RCA Plug | 46Q001-1 |
| | Right Player Cord 5' | 46Q001-2 |
| | Left Player Cord 6' | 46Q001-3 |
| | Speaker 2¼", 8 ohm | 58Q001-1 |
| | Speaker Clamp | 73Q001-2 |
| | Instruction Booklet | 1B3280-1 |

## CABINET REPLACEMENT PARTS LIST

**Note: The cabinet parts listed in this parts list are the only service replaceable cabinet parts.**

**When ordering any replacement parts from this ISM, include the complete Ten (10) Digit Unit Number, and the Part Number with Description as shown in this parts list. Complete information will help expedite your order.**

| DESCRIPTION | PART NO. |
|---|---|
| Top Cabinet | 14Q001-1 |
| Bottom Cabinet | 14Q001-2 |
| Battery Door | 14Q001-3 |
| Front Panel | 14Q001-4 |
| Game Select Switch | 14Q001-5 |
| Terminal Plate Game Cord & DC Jack | 14Q001-6 |
| Top Cabinet Hand Unit (Home Team) | 14Q001-7 |
| Top Cabinet Hand Unit (Visiting Team) | 14Q001-8 |
| Bottom Cabinet Hand Units | 14Q001-9 |
| Push Button Knob | 14Q001-10 |

| DESCRIPTION | PART NO. |
|---|---|
| Control Knob, Hand Units | 14Q001-11 |
| Wire Spring, Neg. Battery Terminal | 10Q001-1 |
| Clip Ring, Selector Knob | 10Q001-2 |
| Bushing, Strain Relief | 10Q001-3 |
| Battery Contact Plate | 73Q001-1 |
| Antenna Game Switch Replacement | |
| Antenna Game Switch | 70Q001-2 |

Fig. 3-33. Parts list for the BG7514.

## ODYSSEY MODEL BG7516

The BG7516 can be powered by 6 C-cells or an optional AC-to-DC 9V adapter. Hockey, tennis, and smash can be played on this model. Also, as a test of your skill, the game incorporates variable ball (english) speed control and the option of two or four players with tennis and hockey. There is also digital on-screen scoring. The game specifications chart for this model is shown in Fig. 3-34. Refer to Fig. 3-35 for the IC functions and voltage charts.

### SERVICE ADJUSTMENTS

Refer to Fig. 3-36 for the location of test points, adjustments, and components. The schematic diagram for this model is located in Fig. 3-37.

#### Horizontal Frequency

1. Connect a frequency counter to pin 16 of IC1.
2. Adjust horizontal frequency control R2 for 15.734 kHz ±30 Hz.

#### Vertical Frequency

1. Connect a frequency counter to pin 14 of IC1.
2. Adjust vertical frequency control R4 for 60 ±1 Hz.

#### Blanking Width & Centering

1. Connect a scope to the composite video output at pin 5 of IC5.
2. Apply 3V DC bias to pin 8 of IC5.
3. Adjust blanking width control R70 for a 16 ms width (Fig. 3-38).
4. Adjust blanking centering control R71 for a 6 ms duration before horizontal sync (Fig. 3-38).

#### Top & Bottom Rebound

1. Connect 3V DC bias to pin 3 of IC3.
2. Rotate right ball control R74 to its maximum counterclockwise position and left ball control R75 to its clockwise position. Only one control will have any effect.
3. Adjust lower rebound control R10 until the entire ball is visible at the bottom of the screen.
4. Turn right ball control R74 to its maximum clockwise position and left ball control R75

| | Minimum | Normal | Maximum |
|---|---|---|---|
| Regulated Voltage Supply Measured at Pin 3 of IC1 | 4.5V | 5.0V | 5.5V |
| Current Drain BG7516 | ----- | 65Ma | ----- |
| Vertical Sync Frequency | 59 Hz | 60 Hz | 61 Hz |
| Pulse Amplitude | 2.8V | 4.0V | ----- |
| Pulse Width | 300 usec | 317.5 usec | 340 usec |
| Horizontal Sync Frequency | 15.704 KHz | 15.734 KHz | 15.784 KHz |
| Pulse Amplitude | 3.5V | 4.0V | ----- |
| Pulse Width | 4.0 usec | ----- | 8.0 usec |
| RF Carrier Frequency Channel 3 | 61.22 MHz | 61.25 MHz | 61.28 MHz |
| Channel 4 | 67.22 MHz | 67.25 MHz | 67.28 MHz |
| RF Output Into 300 ohms | 1100 uV | ----- | 1600 uV |

Fig. 3-34. Game specifications chart for the BG7516.

| (IC1) | | |
|---|---|---|
| PIN | VOLTAGE | NOTE |
| 1 | 0V | ----- |
| 2 | 9.6V | ----- |
| 3 | 5.2V | ----- |
| 4 | 0V | ----- |
| 5 | 2.4V | 4 |
| 6 | .9V | 4 |
| 7 | 1.4V | 5 |
| 8 | 0V | ----- |
| 9 | .8V | ----- |
| 10 | .4V | ----- |
| 11 | 3.8V | ----- |
| 12 | 2.4V | ----- |
| 13 | 3.6V | 7 |
| 14 | .1V | ----- |
| 15 | 5.3V | ----- |
| 16 | .8V | ----- |
| 17 | 2.9V | ----- |
| 18 | 2.3V | ----- |

| (IC2) | | |
|---|---|---|
| PIN | VOLTAGE | NOTE |
| 1 | .4V | ----- |
| 2 | 5.3V | ----- |
| 3 | 3.4V | 8 |
| 4 | 2.3V | ----- |
| 5 | 2.6V | 10 |
| 6 | 3.7V | ----- |
| 7 | 1.5V | ----- |
| 8 | .08V | ----- |
| 9 | .08V | ----- |
| 10 | 4.7V | ----- |
| 11 | 0V | ----- |
| 12 | 2.6V | 11 |
| 13 | .8V | ----- |
| 14 | 2.4V | 9 |
| 15 | 0V | ----- |
| 16 | .08V | ----- |

| (IC3) | | |
|---|---|---|
| PIN | VOLTAGE | NOTE |
| 1 | .4V | ----- |
| 2 | 5.3V | ----- |
| 3 | 2.7V | 1 |
| 4 | 1.5V | 1 |
| 5 | 2.6V | 2 |
| 6 | 3.7V | ----- |
| 7 | 1.4V | ----- |
| 8 | .08V | ----- |
| 9 | .18V | ----- |
| 10 | 1.3V | ----- |
| 11 | 5.3V | ----- |
| 12 | 2.4V | 6 |
| 13 | 1.4V | ----- |
| 14 | 2.6V | 3 |
| 15 | 0V | ----- |
| 16 | .08V | ----- |

| (IC4) | | |
|---|---|---|
| PIN | VOLTAGE | NOTE |
| 1 | .4V | ----- |
| 2 | 5.2V | ----- |
| 3 | 3.4V | 12 |
| 4 | 2.3V | ----- |
| 5 | 2.6V | 10 |
| .6 | 3.7V | ----- |
| 7 | .4V | ----- |
| 8 | .05V | ----- |
| 9 | .05V | ----- |
| 10 | .38V | ----- |
| 11 | 3V | ----- |
| 12 | 2.5V | 11 |
| 13 | .76V | ----- |
| 14 | 2.1V | 13 |
| 15 | 0V | ----- |
| 16 | .07V | ----- |

| (IC5) | | |
|---|---|---|
| PIN | VOLTAGE | NOTE |
| 1 | 5.2V | ----- |
| 2 | 1.8V | 14 |
| 3 | .4V | ----- |
| 4 | .09V | ----- |
| 5 | 1.3V | ----- |
| 6 | .03V | ----- |
| 7 | .06V | ----- |
| 8 | .07V | ----- |
| 9 | .05V | ----- |
| 10 | 1.5V | ----- |
| 11 | 0V | ----- |
| 12 | .7V to 4.5V | 1 |
| 13 | .7V to 4.5V | 1 |
| 14 | .3V to 4.5V | 1 |
| 15 | .2V | ----- |
| 16 | .08V | ----- |

| (IC6) | | |
|---|---|---|
| PIN | VOLTAGE | NOTE |
| 1 | 5.2V | ----- |
| 2 | .7V to 4.5V | 1 |
| 3 | .03V | ----- |
| 4 | 2.6V | ----- |
| 5 | 0V | ----- |
| 6 | .01V | ----- |
| 7 | 1.4V | ----- |
| 8 | 1.4V | ----- |
| 9 | .0V | ----- |
| 10 | 0V | ----- |
| 11 | .08V | ----- |
| 12 | 0V | ----- |
| 13 | 0V | ----- |
| 14 | 1.4V | ----- |
| 15 | .9V | ----- |
| 16 | .4V | ----- |

| (IC7) | | |
|---|---|---|
| PIN | VOLTAGE | NOTE |
| 1 | .17V | ----- |
| 2 | .03V | ----- |
| 3 | 0V | ----- |
| 4 | 0V | ----- |
| 5 | 0V | ----- |
| 6 | 5.2V | ----- |
| 7 | 0V | ----- |
| 8 | 0V | ----- |
| 9 | .4V | ----- |
| 10 | 0V to 5.2V | 1 |
| 11 | 0V to 5.2V | 1 |
| 12 | .9V to 4.2V | 1 |
| 13 | 0V | ----- |
| 14 | 5.2V | ----- |

| TRANSISTOR | | VOLTAGE | NOTE |
|---|---|---|---|
| Q1 | E | 0V | ----- |
| | B | .7V | ----- |
| | C | 1V | ----- |
| Q2 | E | 0V | ----- |
| | B | .7V | ----- |
| | C | 0V | ----- |
| Q4 | E | 0V | ----- |
| | B | .35V to .65V | 1 |
| | C | 0V to 5.2V | 1 |
| Q5 | E | 9.7V | ----- |
| | B | 9.7V | ----- |
| | C | 0V to .1V | 1 |
| Q13 | E | 0V | ----- |
| | B | 0V | ----- |
| | C | 5.2V | ----- |

**NOTES:**

**VOLTAGES TAKEN WITH VTVM, GAME SWITCH IN MIDDLE (TENNIS) POSITION, PLAYERS SWITCH IN "2", SOUND ON, PLAYERS CENTERED AND "BALL" VOLLEYING BETWEEN, CHANNEL SWITCH ON 3.**

1. Voltage varies with Ball Speed & Distance Traveled.
2. Voltage varies with Right or Left Ball Control.
3. Voltage varies with Left Wall Position Control.
4. Voltage varies with Lower Rebound Control.
5. Voltage varies with Upper Rebound Control.
6. Voltage varies with Goal Position Control.
7. Voltage varies with Right Wall Position Control.
8. Voltage varies with Right Player Horizontal Position.
9. Voltage varies with Left Player Horizontal Position.
10. Voltage varies with Right Player Vertical Position.
11. Voltage varies with Left Player Vertical Position.
12. Voltage varies with Right Fixed Player Position.
13. Voltage varies with Left Fixed Player Position.
14. Voltage varies with Blanking Centering & Width.

**IC1**

A. Voltage Regulator
B. Vertical Sync Generator
C. Horizontal Sync Generator
D. Right Wall Generator
E. Rebound Circuitry

**IC2**

A. Right Player Generator
B. Left Player Generator

**IC3**

A. Left Wall Generator
B. Ball Generator

**IC4**

A. Right Back Court Player Generator
B. Left Back Court Player Generator

**IC5**

A. Video Summer
B. Video Output
C. Audio Pulse Generator
D. Logic Circuitry

**IC6**

A. Automatic Scoring Circuitry

**IC7**

A. Automatic Serving Circuitry

Fig. 3-35. IC functions and voltages charts for the BG7516.

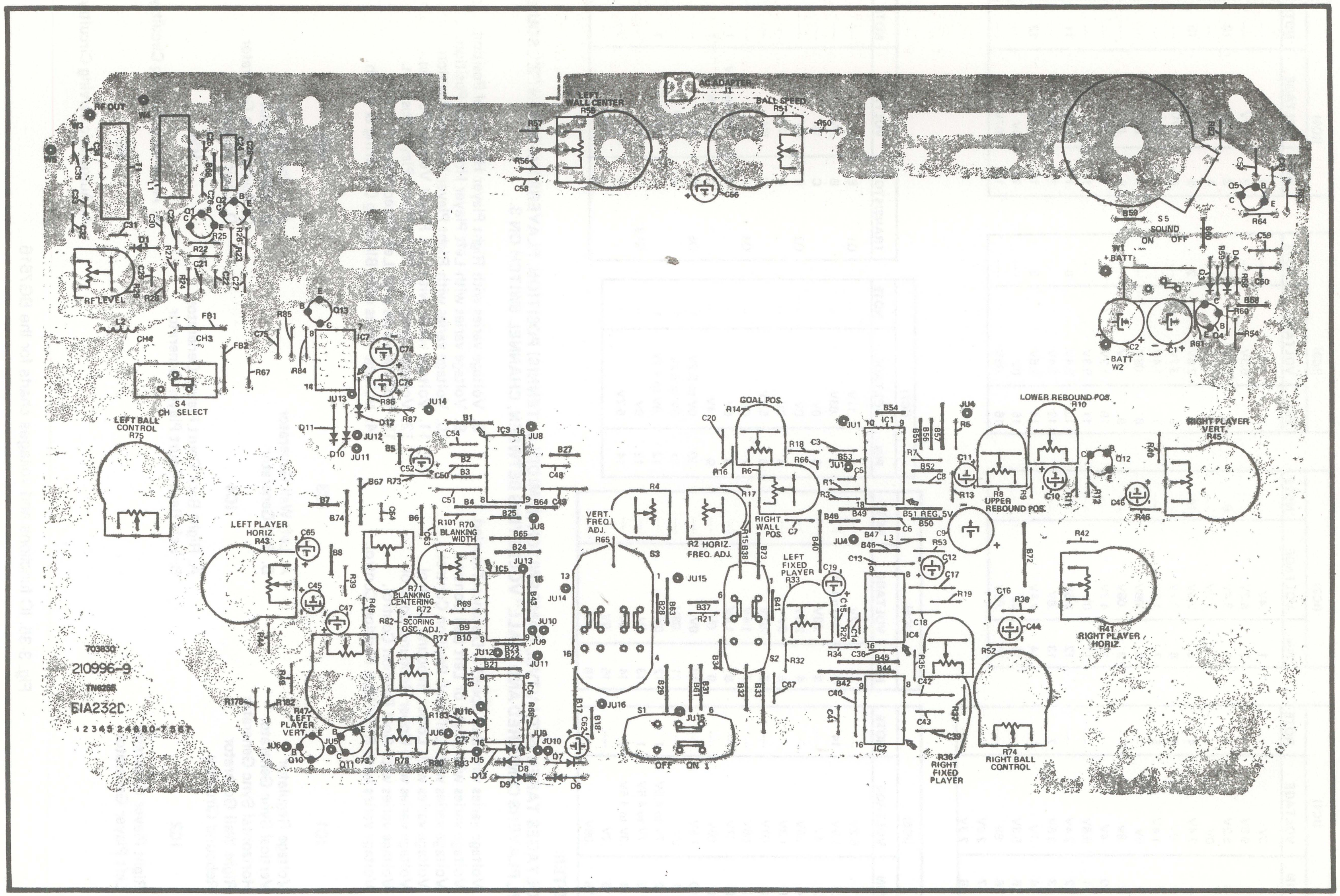


Fig. 3-36. PC board diagram for the BG7516.

to its maximum counterclockwise position.

5. Adjust upper rebound control R9 until the entire ball is visible at the top of the screen.

NOTE

Place the game switch to hockey and the player switch to *4* for the following adjustments.

### Right Wall Horizontal Position

Adjust right wall horizontal control R6 until the right wall is as close as possible to the right side of the screen and still fully visible.

### Goal Opening Position

Adjust goal opening control R14 until the goal openings in both walls are centered vertically.

### Score Indicator Position

Adjust scoring oscillator control R77 until the indicators are equally spaced across the screen.

### Right & Left Fixed Players

1. Adjust left fixed player horizontal control R33 until the player is displaced by approximately its own width to the right of the left wall.
2. Adjust right fixed player horizontal control R36 until the player is displaced by approximately its own width to the left of the right wall.

## REPLACEMENT PARTS

The parts list for the BG7516 is shown in Fig. 3-38 along with the parts list for the antenna/game switch assembly. When ordering parts from the factory, give the model number, part number, description, and schematic symbol if assigned one. Provide as much information as possible about the part in question so that you will be assured of obtaining the correct replacement. Occasionally the replacement differs from the original part; this may be due to an improvement in design by the factory.

# ODYSSEY MODEL BG7520

This Odyssey game unit is powered by a 9V 200 mA AC adaptor. The unit features four games. These are hockey, tennis, smash, and soccer. There are also three different styles of players. For more player skill a ball (english) control and a ball speed control are incorporated.

This video game also features a full color background and color players, automatic ball serve, and digital on-screen scoring. Specifications chart for BG7520 is shown in Fig. 3-40.

## FUNCTION & VOLTAGE INFORMATION

Operating voltages for IC1 through IC8 are shown in Fig. 3-4. These voltages were measured with a high-impedance voltmeter with the supply voltage on pin 2 of IC1 at 9V DC. These voltage readings may vary as much as 20% due to component age and test equipment differences.

Each listing in Fig. 3-4 for individual ICs contains three columns: a pin number column, a voltage column, and a note column. Notes are referenced by numbers 1 through 16. An explanation of each note is given at the bottom of the figure.

Below the IC voltage information is a listing of voltages for the five discrete transistors. You'll notice that in some cases directly after the voltage notation for the emitter, base, or collector, there is a number corresponding to notes given in the lower portion of the figure.

All of the eight IC's in this model perform specific functions in the overall operation of the video game. These major functions are as follows:

**IC1**

- Voltage regulator
- Horizontal sync generator
- Vertical sync generator
- Right wall generator
- Rebound circuitry

**IC2**

- Video logic controller

**IC3**

- Left wall generator
- Ball generator

Continued on page 120.

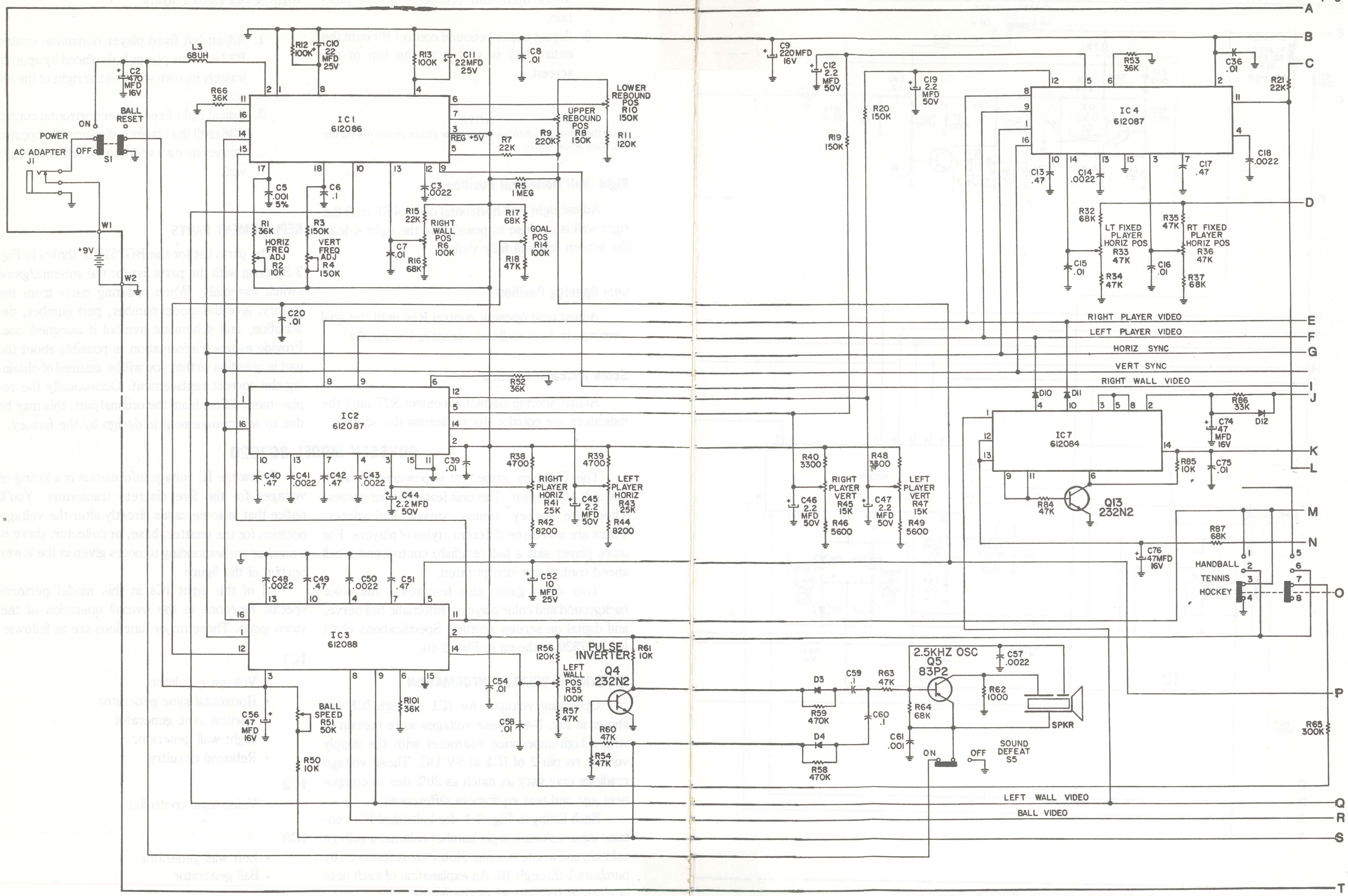



Fig. 3-37. Schematic diagram of the BG7516 (sheet 1 of 4).

Fig. 3-37. (Sheet 2 of 4.)

Continued from page 119.

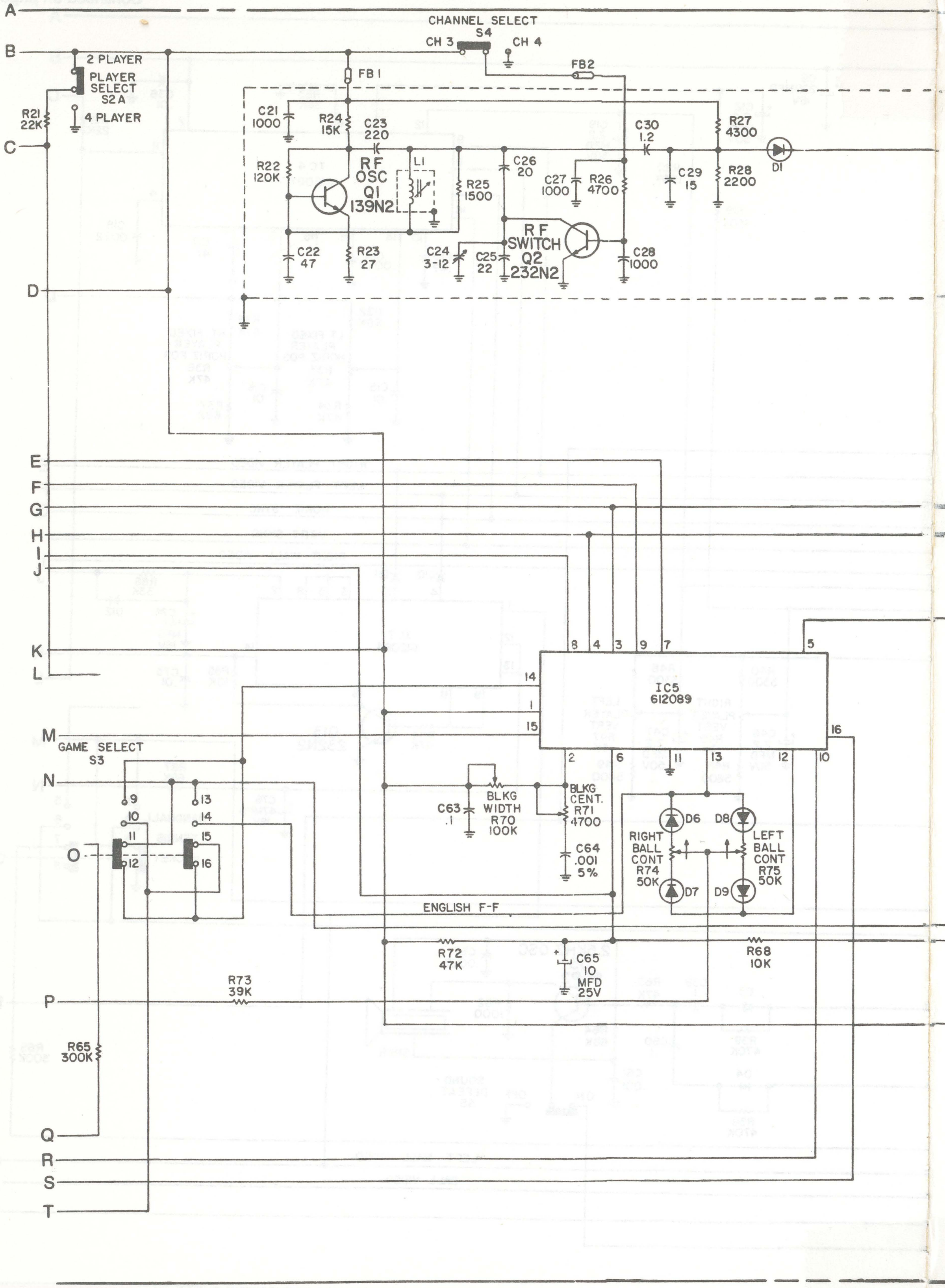
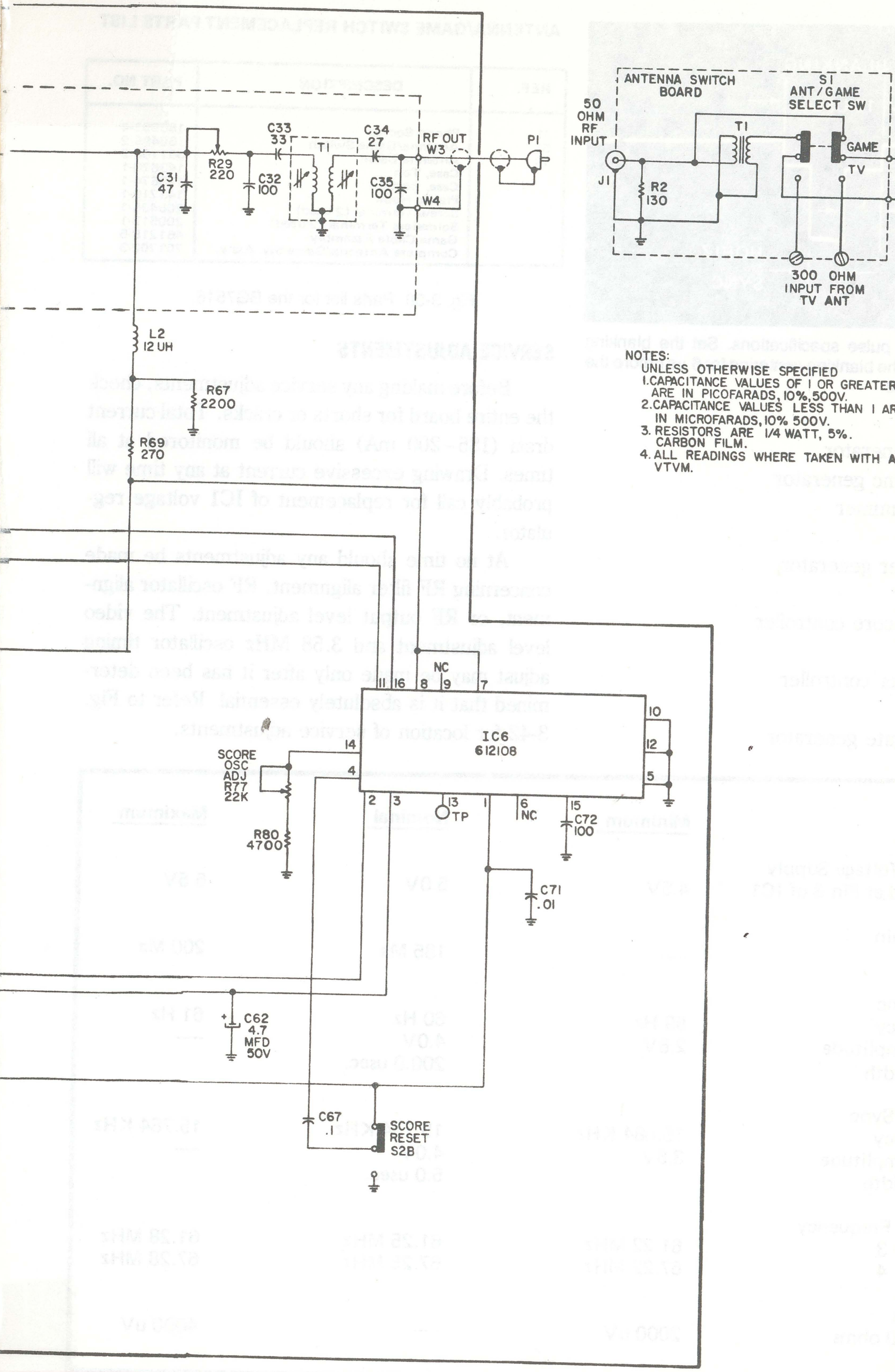



Fig. 3-37. Schematic diagram of the BG7516 (sheet 3 of 4).




NOTES:
UNLESS OTHERWISE SPECIFIED
1. CAPACITANCE VALUES OF 1 OR GREATER ARE IN PICOFARADS, 10%, 500V.
2. CAPACITANCE VALUES LESS THAN 1 ARE IN MICROFARADS, 10% 500V.
3. RESISTORS ARE 1/4 WATT, 5%. CARBON FILM.
4. ALL READINGS WHERE TAKEN WITH A VTVM.

Fig. 3-37. (Sheet 4 of 4.)

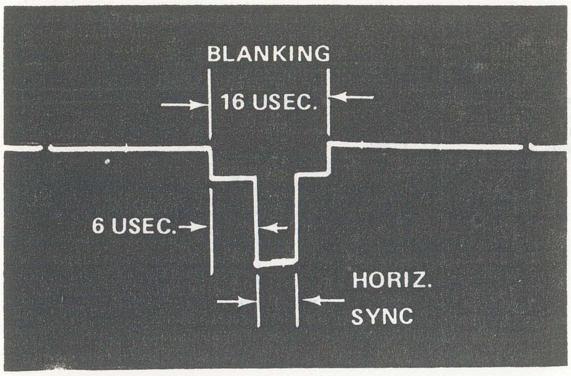



Fig. 3-38. Blanking pulse specifications. Set the blanking width for 16 $\mu$s and the blanking centering for 6 $\mu$s before the horizontal sync pulse.

**IC4**

- Color generator
- Color sync generator
- Video summer

**IC5**

- Character generator

**IC6**

- Digital score controller

**IC7**

- Character controller

**IC8**

- Input, gate generator

**ANTENNA/GAME SWITCH REPLACEMENT PARTS LIST**

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| J1 | Phono Socket | 180902-4 |
| S1 | Antenna/Game Switch | 160499-2 |
| T1 | Antenna Balun | 361108-2 |
| | Case, Top | 143676-1 |
| | Case, Bottom | 143674-1 |
| | Plastic Hook | 143719-1 |
| | Screw Terminal (2 used) | 200495-1 |
| | Solderless Terminal (2 used) | 200517-1 |
| | Game Cable Assembly | 461218-5 |
| | Complete Antenna/Game Sw. Ass'y. | 701702-3 |

Fig. 3-39. Parts list for the BG7516.

## SERVICE ADJUSTMENTS

Before making any service adjustments, check the entire board for shorts or cracks. Total current drain (185–200 mA) should be monitored at all times. Drawing excessive current at any time will probably call for replacement of IC1 voltage regulator.

At no time should any adjustments be made concerning RF filter alignment, RF oscillator alignment, or RF output level adjustment. The video level adjustment and 3.58 MHz oscillator timing adjust may be made only after it has been determined that it is absolutely essential. Refer to Fig. 3-42 for location of service adjustments.

| | Minimum | Nominal | Maximum |
|---|---|---|---|
| Regulated Voltage Supply | | | |
| Measured at Pin 3 of IC1 | 4.5V | 5.0V | 5.5V |
| Current Drain | | | |
| BG7520 | ----- | 185 Ma | 200 Ma |
| Vertical Sync | | | |
| Frequency | 59 Hz | 60 Hz | 61 Hz |
| Pulse Amplitude | 2.8V | 4.0V | ----- |
| Pulse Width | | 200.0 usec. | |
| Horizontal Sync | | | |
| Frequency | 15.684 KHz | 15.734 KHz | 15.784 KHz |
| Pulse Amplitude | 3.5V | 4.0V | ----- |
| Pulse Width | | 5.0 usec. | |
| RF Carrier Frequency | | | |
| Channel 3 | 61.22 MHz | 61.25 MHz | 61.28 MHz |
| Channel 4 | 67.22 MHz | 67.25 MHz | 67.28 MHz |
| RF Output | | | |
| Into 300 ohms | 2000 uV | ----- | 4000 uV |

Fig 3-40. Game specifications of the BG7520.

| IC1 | | | IC2 | | | IC3 | | | IC4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE |
| 1 | 0 | ----- | 1 | 5.25 | ----- | 1 | .3 | ----- | 1 | .7 - 4.4 | 2 |
| 2 | 9.0 | ----- | 2 | 1.3 - 5.25 | 12 | 2 | 5.25 | ----- | 2 | 0 | ----- |
| 3 | 5.25 | ----- | 3 | .3 | ----- | 3 | 2.5 - 3.1 | 1 | 3 | .75 - 1 | 13 |
| 4 | 0 | ----- | 4 | 0 | ----- | 4 | 1.4 - 2 | 1 | 4 | 2.6 | ----- |
| 5 | 2.6 | ----- | 5 | 3.7 | ----- | 5 | 2.6 | 2 | 5 | 2.6 | ----- |
| 6 | .5 - 1.1 | 4 | 6 | 0 | ----- | 6 | 3.83 | ----- | 6 | 1.4 | ----- |
| 7 | 1.2 - 1.7 | 5 | 7 | .1 | ----- | 7 | 1.3 | ----- | 7 | 0 | ----- |
| 8 | 0 | ----- | 8 | .1 | ----- | 8 | .11 | ----- | 8 | 3.7 | ----- |
| 9 | .1 | ----- | 9 | .13 | ----- | 9 | .2 | ----- | 9 | 0 | ----- |
| 10 | .2 | ----- | 10 | .2 | ----- | 10 | 1.45 | ----- | 10 | 0 | ----- |
| 11 | 4.01 | ----- | 11 | 0 | ----- | 11 | 5.25 | ----- | 11 | .3 | ----- |
| 12 | 2.35 | ----- | 12 | .7 - 4.5 | 2 | 12 | 1.1 - 3.5 | 6 | 12 | 1.2 - 4.2 | 14 |
| 13 | 1.7 - 4.7 | 7 | 13 | .7 - 4.4 | 2 | 13 | 1.5 | ----- | 13 | 1.87 | ----- |
| 14 | .05 | ----- | 14 | 0 - 4.6 | 1 | 14 | 1.5 - 3.1 | 3 | 14 | 5.25 | ----- |
| 15 | 5.25 | ----- | 15 | 5.25 | ----- | 15 | 0 | ----- | 15 | 0 | ----- |
| 16 | .3 | ----- | 16. | .11 | ----- | 16 | 0 | ----- | 16 | 0 | ----- |
| 17 | 0 | ----- | | | | | | | 17 | .1 | ----- |
| 18 | 0 | ----- | | | | | | | 18 | .11 | ----- |
| | | | | | | | | | 19 | 0 | ----- |
| | | | | | | | | | 20 | .2 | ----- |

| IC5 | | | IC6 | | | IC7 | | | IC8 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE | PIN | VOLTAGE | NOTE |
| 1 | 0 | ----- | 1 | 5.25 | ----- | 1 | 3.81 | ----- | 1 | .2 | ----- |
| 2 | 0 | ----- | 2 | .7 - 4.4 | 2 | 2 | 1.3 - 4.5 | 9 | 2 | 1.45 | ----- |
| 3 | 0 | ----- | 3 | .1 | ----- | 3 | 1.3 | ----- | 3 | 0 | ----- |
| 4 | 0 | ----- | 4 | 2.63 | ----- | 4 | 1.3 - 4.5 | 11 | 4 | 0 | ----- |
| 5 | 0 | ----- | 5 | 0 | ----- | 5 | 1.6 | ----- | 5 | 0 | ----- |
| 6 | .2 | ----- | 6 | .13 | ----- | 6 | 0 | ----- | 6 | 5.25 | ----- |
| 7 | .1 | ----- | 7 | 0 | ----- | 7 | .55 - .61 | 16 | 7 | 0 | ----- |
| 8 | 0 | ----- | 8 | 0 | ----- | 8 | .3 | ----- | 8 | 0 | ----- |
| 9 | 1.7 | ----- | 9 | .1 | ----- | 9 | 5.25 | ----- | 9 | 0 - 5 | 1 |
| 10 | 0 | ----- | 10 | 0 | ----- | 10 | .15 | ----- | 10 | 0 | ----- |
| 11 | .07 | ----- | 11 | 0 | ----- | 11 | .26 | 16 | 11 | 0 - 5 | 1 |
| 12 | 0 | ----- | 12 | 0 | ----- | 12 | .3 | ----- | 12 | 2.2 - 3.3 | 1 |
| 13 | 0 | ----- | 13 | 0 | ----- | 13 | 1.6 | ----- | 13 | 2.2 - 3.3 | 1 |
| 14 | 0 | ----- | 14 | 1.2 - 1.4 | 15 | 14 | 1.3 - 4.5 | 10 | 14 | 5.25 | ----- |
| 15 | 1.0 | ----- | 15 | .9 | ----- | 15 | 2.2 | ----- | | | |
| 16 | 0 | ----- | 16 | .3 | ----- | 16 | 1.3 - 4.5 | 8 | | | |
| | | | | | | 17 | 0 | ----- | | | |
| | | | | | | 18 | 0 | ----- | | | |

| TRANSISTOR | Q1 | Q2 | Q3 | Q4 | Q5 |
|---|---|---|---|---|---|
| VOLTAGE, NOTE | E 0<br>B 0 - .65V, 1<br>C 5.25V | E 0<br>B .3 - .6, 1<br>C 0 - 5.25, 1 | E 9.75<br>B 9.69<br>C 0 - .2 | E 0<br>B .64<br>C 1.15 | E 0<br>B .05<br>C 1.58 |

**NOTES:**

VOLTAGES TAKEN WITH VTVM, LINE VOLTAGE MAINTAINED TO PROVIDE 9 VDC AT PIN 2 OF IC1, OPERATING ON CHANNEL 4, SOUND ON, GAME/PLAYER SWITCHES IN CENTER (TENNIS) POSITION, BALL ADJUSTED FOR LOWEST SPEED, VOLLEYING BETWEEN CENTERED PLAYERS.

1. Voltage varies with Ball Speed and distance traveled.
2. Voltage varies with Right or Left Ball Control.
3. Voltage varies with Left Wall Position Control.
4. Voltage varies with Lower Rebound Control.
5. Voltage varies with Upper Rebound Control.
6. Voltage varies with Goal Position Control.
7. Voltage varies with Right Wall Position Control.
8. Voltage varies with Right Player Horizontal Position.
9. Voltage varies with Left Player Horizontal Position.
10. Voltage varies with Right Player Vertical Position.
11. Voltage varies with Left Player Vertical Position.
12. Voltage varies with Blanking Centering and Width.
13. Voltage varies with Background Adjust Control.
14. Voltage varies with Video Level Adjust.
15. Voltage varies with Score Oscillator Adjust.
16. Voltage varies with Player Size Balance Adjust

Fig. 3-41. Voltage charts for the BG7520

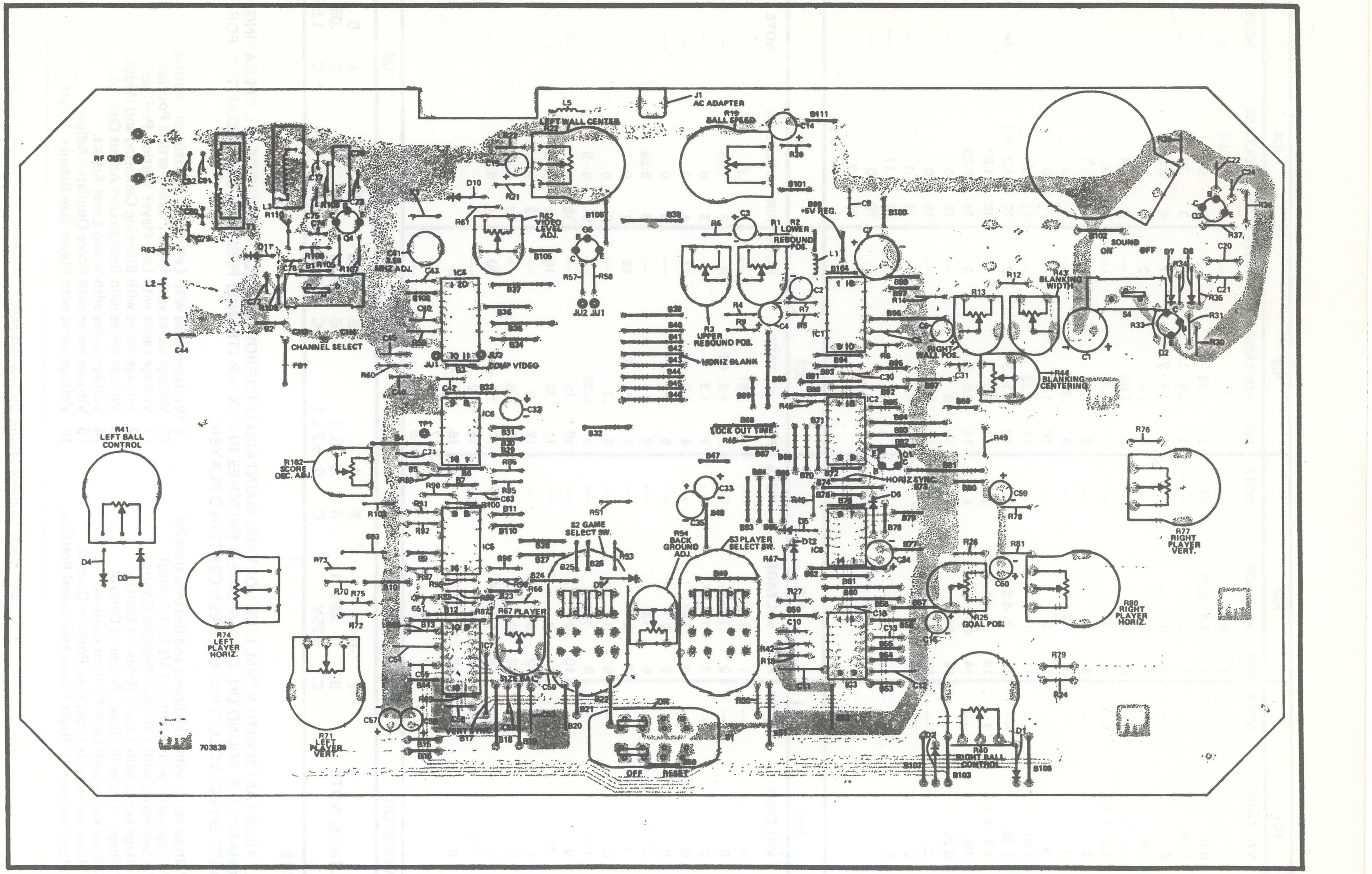



Fig. 3-42. PC board diagram of the BG7520.

### Score Indicator Position

1. Obtain W-W win indicators on the screen by momentarily placing the power 1 reset switch to the off position, then back on.
2. Adjust score oscillator control R102 to visually center the letters on the raster.

### Top & Bottom Rebound

1. Connect 3V DC bias to pin 3 of IC3.
2. Turn right ball control R40 to its fully clockwise position and left ball control R41 to its fully counterclockwise position.
3. Adjust upper rebound control R3 until the entire ball is visible at the top edge of the screen.
4. Turn right ball control R40 to its fully counterclockwise position and left ball control R41 to its fully clockwise position.
5. Adjust lower rebound control R2 until the entire ball is visible at the bottom edge of the screen.

### Blanking Width & Centering

1. Connect the scope to pin 5 of IC2.
2. Adjust blanking width control R43 for a blanking pulse width of 14 ms (Fig. 3-43).
3. Adjust blanking centering control R44 for horizontal sync for 3 ms (Fig. 3-43) after the leading edge of the horizontal blanking pulse.

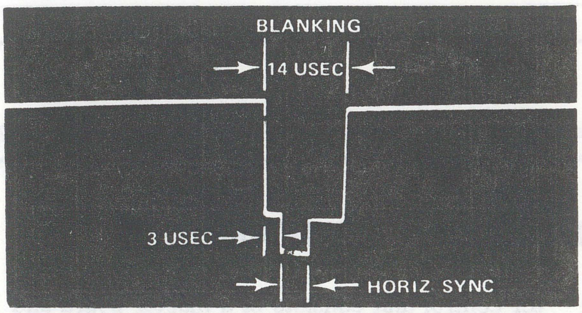



Fig. 3-43. Horizontal blanking pulse. Set the blanking width for 14 $\mu$s and blanking centering for 3 $\mu$s before the horizontal sync pulse.

### Video Level

1. Adjust video level control R62 until good contrast in the picture is obtained.

### 3.58 Oscillator Timing

1. Place game and player select switches in the tennis position.
2. Using an insulated screwdriver, adjust 3.58 MHz trimmer C41. Tune trimmer capacitor C41 for a light-green background, a light-blue left player, and a yellow right player.

### Background Color Control

This adjustment can be made on a color TV receiver only.

1. Adjust background color control R54 for a green background. Potentiometer R54 will affect the background only.
2. Check screen background color in the hockey, smash, and soccer switch positions. Hockey should appear cyan, smash magenta, and soccer red.

### Player Size Balance

1. Place the player select switch in the smash position.
2. Superimpose the left and right player on the screen.
3. Adjust player size balance control R67 to obtain equal character size.

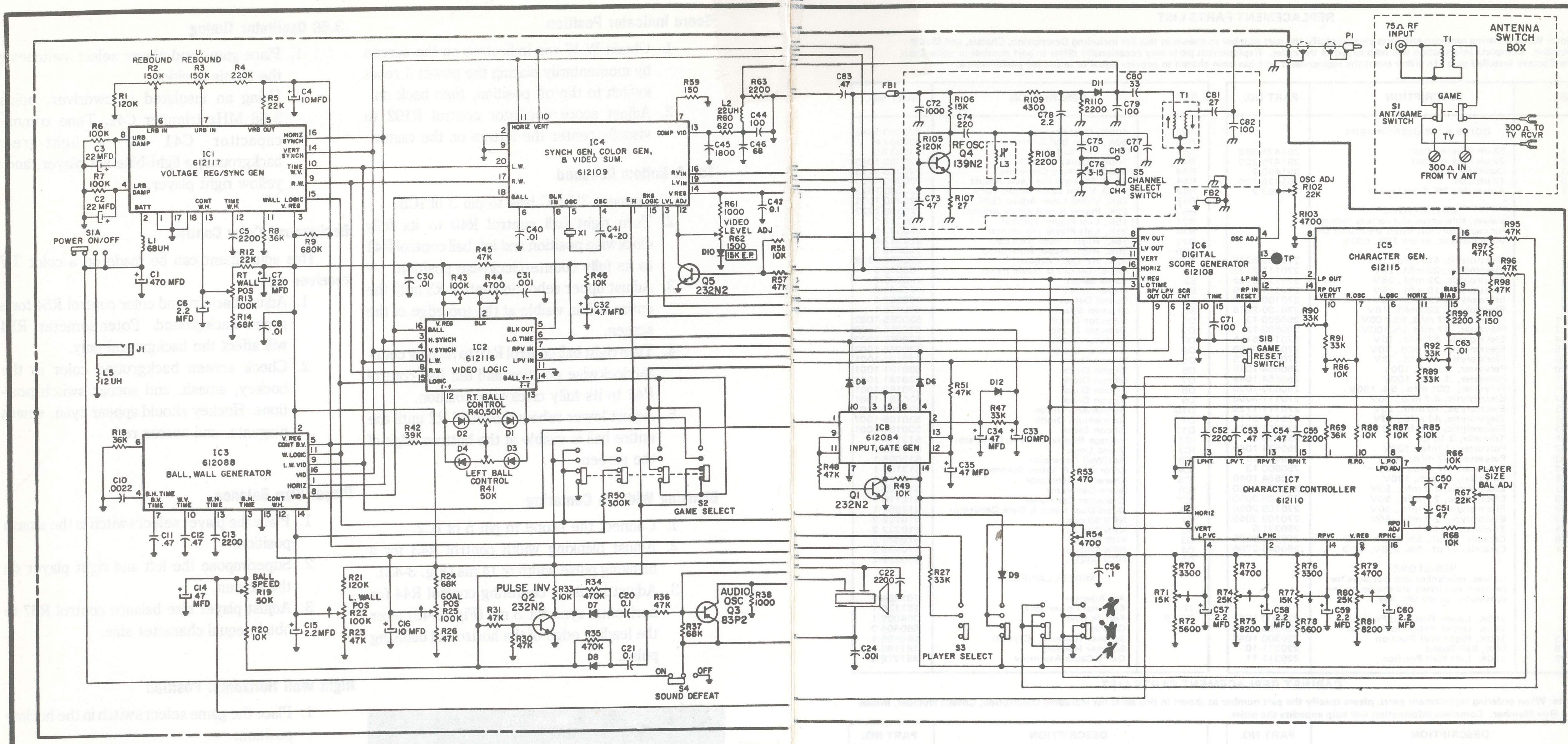
### Right Wall Horizontal Position

1. Place the game select switch in the hockey position.
2. Adjust right wall control R13 until the entire right wall is visible on the right edge of the screen.

### Goal Opening Position

1. Place the game select switch in the hockey position.
2. Adjust goal position control R25 until the goal is positioned vertically in the center of the screen.

The complete schematic for Model BG7520 video game is shown in Fig. 3-44. Refer to Fig. 3-45 for replacement parts list.




NOTES:
UNLESS OTHERWISE SPECIFIED:
1. RESISTORS ARE 1/4 WATT, 5% TOLERANCE.
2. CAPACITANCE VALUES OF ONE OR MORE ARE IN PICOFARADS.
3. CAPACITANCE VALUES LESS THAN ONE ARE IN MICROFARADS.

Fig. 3-44. Schematic diagram of the BG7520 (sheet 1 of 2).

Fig. 3-44. (Sheet 2 of 2.)

# ITL200 BK12 & BLAK ODYSSEY GAME SIMULATORS

This Odyssey unit is an electronic game simulator developed by Magnavox as a consumer leisure time product. The basic game set consists of a master control unit, antenna/game switch box and the cables necessary to interconnect the electronic circuitry. Also included are game overlays, poker chips, and other items for playing the various games. The rifle shoot game is an option. The master control unit consists of a master board and 12 solid-state plug-in modules. An overall block diagram of this unit is shown in Fig. 3-46.

The video game is connected as illustrated in Fig. 3-47. The master control unit generates the video, sync, and RF signals necessary to produce two players, a ball, and a wall on the TV receiver screen.

## INSTALLATION NOTES

Plug the player control unit cables into the master control unit as illustrated in Fig. 3-47. The two player control units are identical. The accessory rifle is also shown in Fig. 3-47.

The game cord is used to connect the master control unit to the antenna/game switch. Insert one end of the game cord into the socket marked GAME CORD on the master control unit. The other end plugs into the socket on the top of the antenna/game switch marked GAME CORD.

The antenna/game switch is a convenience to allow selection of the game or TV reception without disconnecting the antenna lead. Connect the lead from the antenna/game switch to the set's VHF terminals. When changing from game to TV, make certain the slide switch is to either extreme side position and not in the middle.

Set the television to the VHF channel (3 or 4) on which the game will be displayed. Plug one end of the game cord into the game cord socket on the antenna/game switch and place the switch in the

## REPLACEMENT PARTS LIST

**Note: When ordering replacement parts please specify the part number as shown in this list including Description, Chassis, and Model Number. Complete information will help expedite the order. Replacement parts may occasionally differ in part number or value from the Factory installed part. In either event the replacement part has been chosen to provide equal or improved performance.**

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | COILS & TRANSFORMERS | |
| L1 | 68 uh Peaking Coil | 361475-680 |
| L2 | 22 uh Peaking Coil | 361475-220 |
| L3 | Oscillator Coil | 361495-2 |
| L5 | 12 uh Coil | 361425-120 |
| T1 | Adjustable RF Transformer | 361467-2 |
| | CAPACITORS | |
| | Values, tolerances and voltage ratings for capacitors not listed are shown on the schematic, or are 10%, 500V. | |
| C1 | Electrolytic, 470 mfd., 16V | 270109 5215 |
| C2 | Electrolytic, 22 mfd., 25V | 270111-2125 |
| C3 | Electrolytic, 22 mfd., 25V | 270111-2125 |
| C4 | Electrolytic, 10 mfd., 25V | 270111-1125 |
| C6 | Electrolytic, 22 mfd., 50V | 270109-2050 |
| C7 | Electrolytic, 220 mfd., 16V | 270109-2215 |
| C11 | Polyester, .47 mfd.,5%,100V | 250600-13 |
| C12 | Polyester, .47 mfd.,5%,100V | 250600-13 |
| C14 | Electrolytic, 47 mfd., 16V | 270111-5115 |
| C15 | Electrolytic, 2.2 mfd., 50V | 270109-2050 |
| C16 | Electrolytic, 10 mfd., 25V | 270111-1125 |
| C20 | Polyester, .1 mfd., 100V | 250654-1049 |
| C21 | Polyester, .1 mfd., 100V | 250654-1049 |
| C31 | Polyester, .001 mfd., 5%, 150V | 250635-1025 |
| C32 | Electrolytic, 4.7 mfd., 50V | 270111-5050 |
| C33 | Electrolytic, 10 mfd., 25V | 270111-1125 |
| C34 | Electrolytic, 47 mfd., 16V | 270111-5115 |
| C35 | Electrolytic, 47 mfd., 16V | 270111-5115 |
| C41 | Trimmer, 3-15 pf. | 260220-4 |
| C42 | Polyester, .1 mfd., 100V | 250654-1049 |
| C53 | Polyester, .47 mfd., 100V | 250600-13 |
| C54 | Polyester, .47 mfd., 100V | 250600 13 |
| C56 | Polyester, .1 mfd., 100V | 250654 1049 |
| C57 | Electrolytic, 2.2 mfd., 50V | 270109-2050 |
| C58 | Electrolytic, 2.2 mfd., 50V | 270109 2050 |
| C59 | Electrolytic, 2.2 mfd., 50V | 270109 2050 |
| C60 | Electrolytic, 2.2 mfd., 50V | 270109 2050 |
| C76 | Trimmer, 3-15 pf. | 250371-6 |
| C80 | Ceramic, 33 pf., 5%, 500V, NPO | 250546-3305 |
| C81 | Ceramic, 27 pf., 5%, 500V, NPO | 250546-2705 |
| | RESISTORS | |
| | Values, tolerances and wattages for resistors not listed are shown on the schematic, or are 5%, ¼W. | |
| R2 | 150K, Lower Rebound Position | 220300 1542 |
| R3 | 150K, Upper Rebound Position | 220300-1542 |
| R13 | 100K, Right Wall Position | 220300-1043 |
| R19 | 50K, Ball Speed | 220311-10 |
| R22 | 100K, Left Wall Position | 220311-11 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| R25 | 100K, Goal Position | 220300-1043 |
| R40 | 50K, Right Ball Control | 220337-6 |
| R41 | 50K, Left Ball Control | 220337-6 |
| R43 | 100K, Blanking Width | 220300-1043 |
| R44 | 4700, Blanking Centering | 220300-4723 |
| R54 | 4700, Background Level Adjust | 220300-4723 |
| R62 | 1500, Video Level Adjust (LP) | 220300-1523 |
| R62 | 15K, Video Level Adjust (EP) | 220300-1533 |
| R67 | 22K, Player Size Balance Adjust | 220300-2233 |
| R71 | 15K, Left Player Vertical | 220337-4 |
| R74 | 25K, Left Player Horizontal | 220337-5 |
| R77 | 15K, Right Player Vertical | 220337-4 |
| R80 | 25K, Right Player Horizontal | 220337-5 |
| R102 | 22K, RF Osc. Adjust | 220300-2233 |
| S1 | Power/On-Off & Game Reset | 160546-5 |
| S2 | Game Select | 160546-2 |
| S3 | Player Select | 160546-2 |
| S4 | Sound Defeat | 160556-1 |
| S5 | Channel Select | 160556-1 |
| D1 | Detector Diode | 530065-1002 |
| D2 | Detector Diode | 530065-1002 |
| D3 | Detector Diode | 530065-1002 |
| D4 | Detector Diode | 530065-1002 |
| D5 | Silicon Diode | 530181-1001 |
| D6 | Silicon Diode | 530181-1001 |
| D7 | Silicon Diode | 530181-1001 |
| D8 | Silicon Diode | 530181-1001 |
| D9 | Silicon Diode | 530181-1001 |
| D10 | Germanium Diode | 530105-1001 |
| D11 | Germanium Diode | 530105-1001 |
| D12 | Silicon Diode | 530181-1001 |
| IC1 | Voltage Regulator/Sync Generator | 612117-1 |
| IC2 | Video Logic | 612116-1 |
| IC3 | Ball/Wall Generator | 612088-1 |
| IC4 | Color Gen. & Video Summer | 612109-1 |
| IC5 | Character Generator | 612115-1 |
| IC6 | Score Generator | 612108-2 |
| IC7 | Character Controller | 612110-1 |
| IC8 | Quad/Dual Input & Gate Generator | 612084-1 |
| Q1 | NPN Silicon | 610232-2 |
| Q2 | NPN Silicon | 610232-2 |
| Q3 | PNP Silicon | 610083-2 |
| Q4 | NPN Silicon | 610139-2 |
| Q5 | NPN Silicon | 610232-2 |
| | MISCELLANEOUS | |
| | AC Adaptor | 701284-6 |
| J1 | External Power Jack | 181139-1 |
| FB1,2 | Ferrite Bead | 364005-1 |
| X1 | Crystal | 560404-2 |
| | Speaker (Ceramic Crystal) | 560406-1 |
| | Speaker Housing | 181189-1 |
| | Game Cable Assembly | 461218-5 |

## CABINET REPLACEMENT PARTS LIST

**Note: When ordering replacement parts, please specify the part number as shown in this parts list including Description, Chassis Number, Model and Run Number. Complete information will help expedite the order.**

| DESCRIPTION | PART NO. |
|---|---|
| Case, Top | 143670-6 |
| Case, Bottom | 143669-6 |
| Control Knob | 143689-6 |
| Control Knob | 143689-7 |
| Switch Inlay | 151449-3 |
| Switch Inlay | 151449-5 |

| DESCRIPTION | PART NO. |
|---|---|
| Top Inlay | 151483-3 |
| Knob, Underlay Skirt | 151482-1 |
| Foot, Black | 141737-3 |
| "O" Ring Retainer | 103082-4 |
| Spring Lock Nut | 103235-1 |
| Stud, Cover Holding | 732953-2 |

## ANTENNA/GAME SWITCH REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| J1 | Phono Socket | 180902-4 |
| S1 | Antenna/Game Switch | 160499-2 |
| T1 | Antenna Balun | 361108-2 |
| | Case, Top | 143676-1 |
| | Case, Bottom | 143674-1 |
| | Plastic Hook | 143719-1 |
| | Screw Terminal (2 used) | 200495-1 |
| | Solderless Terminal (2 used) | 200517-1 |
| | Game Cable Assembly | 461218-5 |
| | Complete Antenna/Game Sw. Ass'y. | 701702-3 |

## ANTENNA/GAME SWITCH

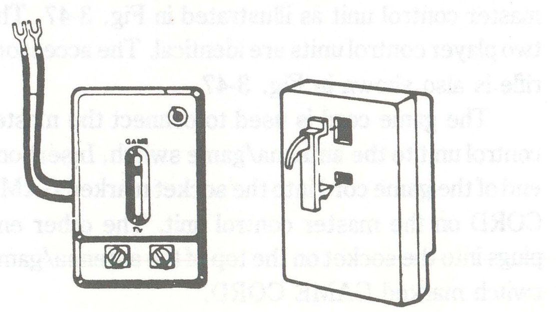



Fig. 3-45. Parts list for the BG7520.

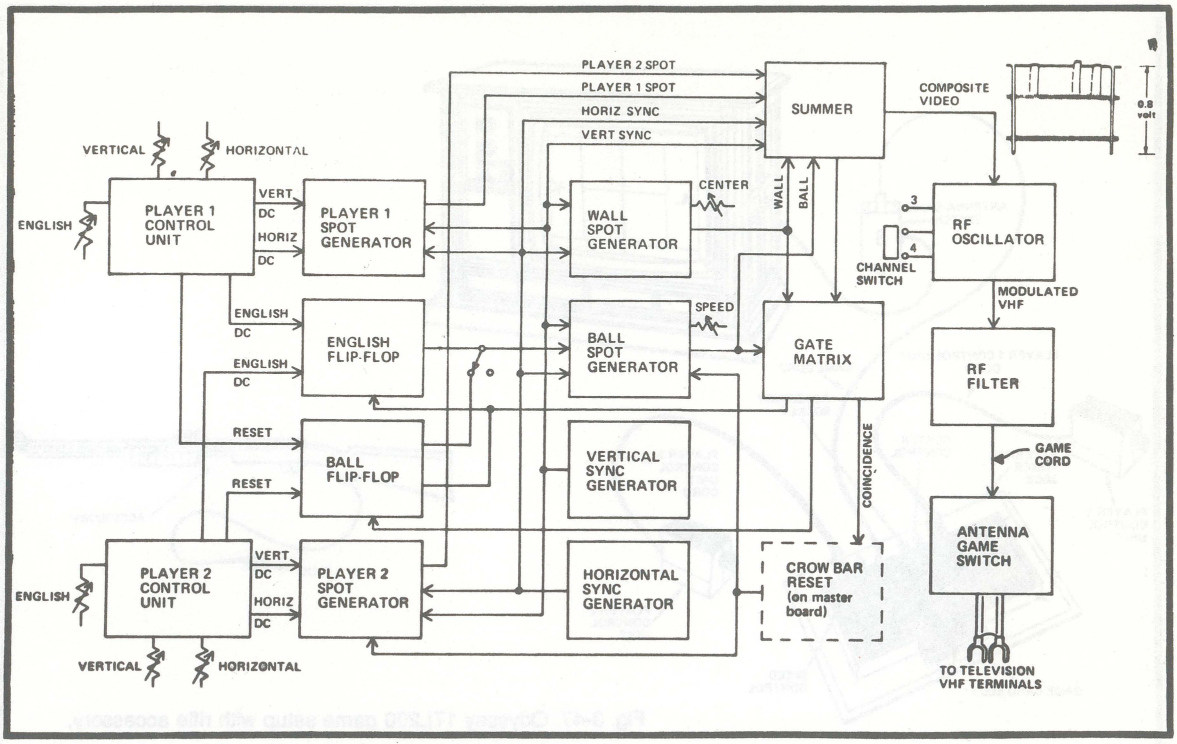



Fig. 3-46. Block diagram of the 1TL200 game similator.

game position. Insert game card 1 for table tennis in the game card slot on the master control unit; press down firmly until it is completely plugged in. The number 1 should be facing outward. The game card is also the power switch for the master control unit, so a signal is now being sent to the TV receiver. It is very important to remove the game card after playing to turn off power and not deplete the battery.

Look for a white vertical line from the top to bottom and possibly one or two small white squares. Adjust the VHF fine tuning on the set, if needed, until this vertical line is straight and clear. Also adjust the brightness and contrast controls for a bright white line against a dark-gray background.

The center control on the master control unit should be adjusted until the vertical line is in the center of the TV screen.

## TROUBLE CHECKOUT PROCEDURE

1. Visually inspect the master control unit, player control units, and cables for breakage, cracks, broken or bent connector pins, broken wires, corrosion, or other damage.
2. Check for correctly installed batteries.
3. Check the channel switch setting in the battery compartment. Insert game card 1 into the master control unit.
4. If there is no player image on the TV screen when a game card is inserted then make the following checks:
   a. Rotate the horizontal and vertical controls on both player control units. If the player images do not appear on the screen, continue on with the checks.
   b. Make sure that the channel selector on the TV set is at the correct channel (3 or 4) as dictated by the channel switch in the master control unit.
   c. See that the game card is inserted properly with the number facing outward and is plugged in all the way.
   d. See that the antenna/game switch is in the game position and that the antenna/game switch has been properly installed.
   e. See that the game cord is plugged into the socket provided on the top of

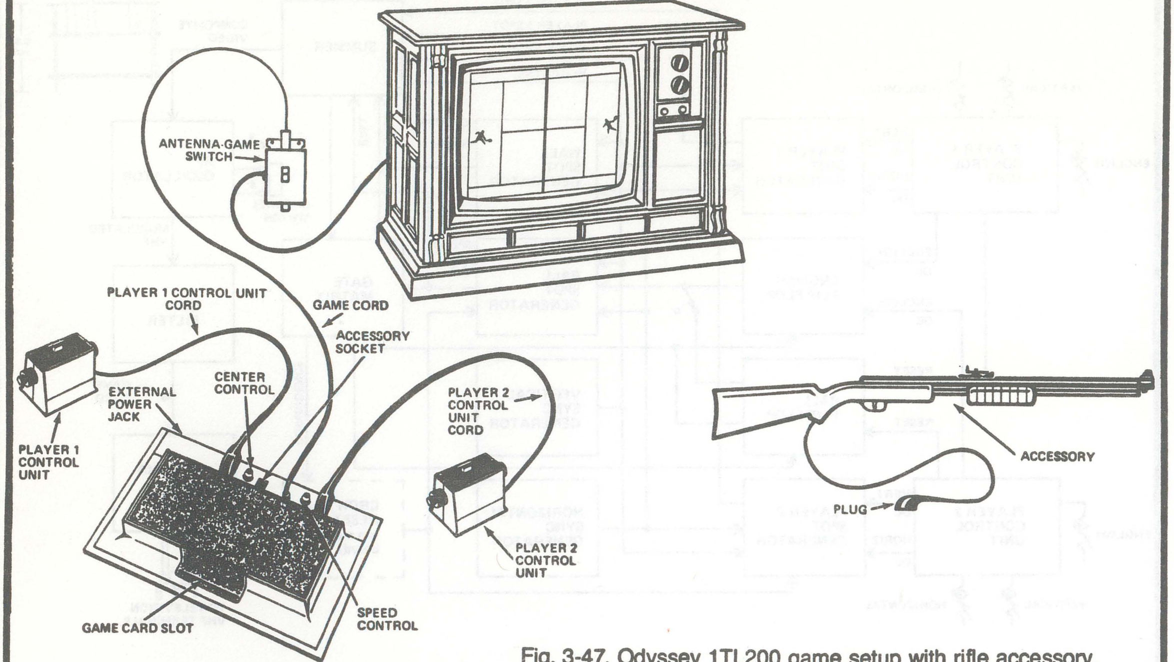



Fig. 3-47. Odyssey 1TL200 game setup with rifle accessory.

the antenna/game switch and on the back of the master control unit.

f. Connect an external 9V power supply to J1. If the unit now operates normally, replace all batteries.

g. See if the contacts of J1 close when external power plug is removed. If J1 contacts do not press together, bend until good contact is made. Then check the operation with an external 9V power supply. Jack J1 is accessible through the battery compartment.

5. If trouble is experienced with one or more games, make the following checks:

a. Be sure the proper game card is properly inserted in the master control unit.

b. Check game card for any visible damage to the card.

c. If no players, ball, or wall appear on the TV screen, try a new game card.

d. If one player does not appear or cannot be controlled, or if control of ball by that player control unit is abnormal, unplug the player control units and switch them. If problem changes to the other side, a player control unit is defective and should be replaced.

e. If the preceding steps fail to locate the problem, the master control unit is at fault and should be repaired.

f. If the unit operates normally except with accessories, check the accessory connections. Test the unit with a new accessory. If the fault disappears, the original accessory is defective; if not, repair the master control unit.

## MASTER CONTROL UNIT

The master control unit contains a master board on which are mounted the game card, game cord, player and accessory connectors, adjustment pots, and twelve plug-in modules. Servicing of the master control unit consists of isolating any malfunction to a specific adjustment or defective module, then making the appropriate adjustment, repair or replacing the module.

The illustration in Fig. 3-48 shows the location and function of modules and adjustments on the master board. The adjustment potentiometers can be turned with a small screwdriver. The modules all plug vertically into sockets mounted on the board; to remove a module, grasp by the edges and gently lift one end out. If any difficulty is encountered, use a small screwdriver to lift the plastic strip at the end of the socket to unlock the module.

## SERVICE ADJUSTMENTS

Potentiometers on the master board are used to adjust size of spots and frequencies of the vertical and horizontal sync generators. Looking at the face of the pots, clockwise rotation increases that function. Note the master board reference guide shown in Fig. 3-49.

All adjustments are made with unit connected as per *Installation Notes*. Fine tune and adjust brightness and contrast controls on the TV set for the best display. Use game card 1.

### Vertical Frequency

1. Connect the frequency counter's hot lead to TP2 (vertical test point) and the ground lead to point W2.
2. Adjust vertical frequency control R39 for 60 Hz.

### Horizontal Frequency

1. Connect the frequency counter's hot lead to TP3 (horizontal test point) and the ground lead to point W2.
2. Adjust horizontal frequency control R38 for 15.734 kHz ±50 Hz.
3. Perform one of the two TV-to-game horizontal sync procedures.

### Color TV Monitor

1. Select a high-band VHF channel.
2. Fine tune the TV for the best reception.
3. Place the TV receiver in a mode that disables horizontal sync to the horizontal oscillator, permitting the oscillator to free run.
4. Adjust the TV's horizontal hold control until the TV syncs with the TV station sync.
5. Return the TV set's horizontal sync input to the horizontal oscillator.
6. Connect the Odyssey master control unit to the TV set.
7. Place the channel select or switch in the channel 4 position and insert game card 2 into the slot.
8. Place the antenna/game switch in the TV position. Tune the TV to channel 3 and fine tune for best reception.
9. Place the antenna/game switch in the game position. If the frequency is off, the diagonal lines will be almost to the point of being horizontal.
10. Adjust pot R38 (located on the master board) until the horizontal lines are vertical. At this point the horizontal frequency is very close to the correct frequency.

### Monochrome Monitor

1. Select a high-band VHF channel.
2. Fine tune the TV for the best reception.
3. Continue to fine tune into the sound modulation, where horizontal bars are evident.
4. Adjust the TV's horizontal hold control until the horizontal blanking bar is vertical on the screen. The horizontal hold control is now adjusted to approximately ±5 Hz of the station sync.

### Spot Size

1. Adjust the player control units to position player 1 on the left and player 2 on the right side of the screen.
2. Use centering control R12 to put the wall at midpoint of the screen.
3. The table in Fig. 3-50 shows the relative spot size in inches for various TV picture tube sizes. Pick the size of the TV you are using or the listed size that is closest; the spot dimensions are listed on the same line. Use a ruler or tape to measure the spot size during adjustments.
4. Adjust wall width control R17 until the wall is the size shown in the table (3/4 inch on a 25-inch screen).
5. Adjust player 1 width control R26 for proper width of player 1.

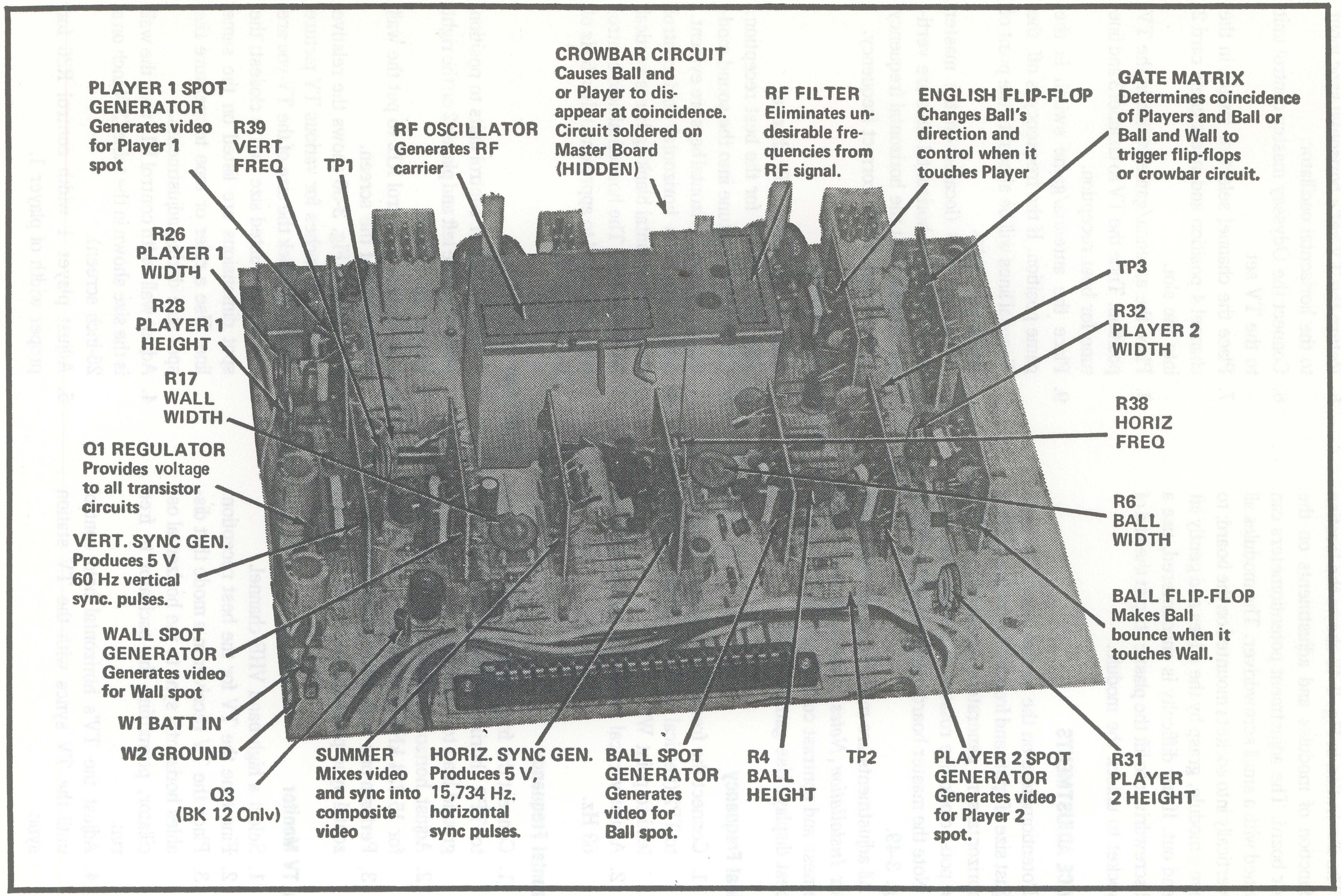



Fig. 3-48. Master board location diagram for the 1TL200.

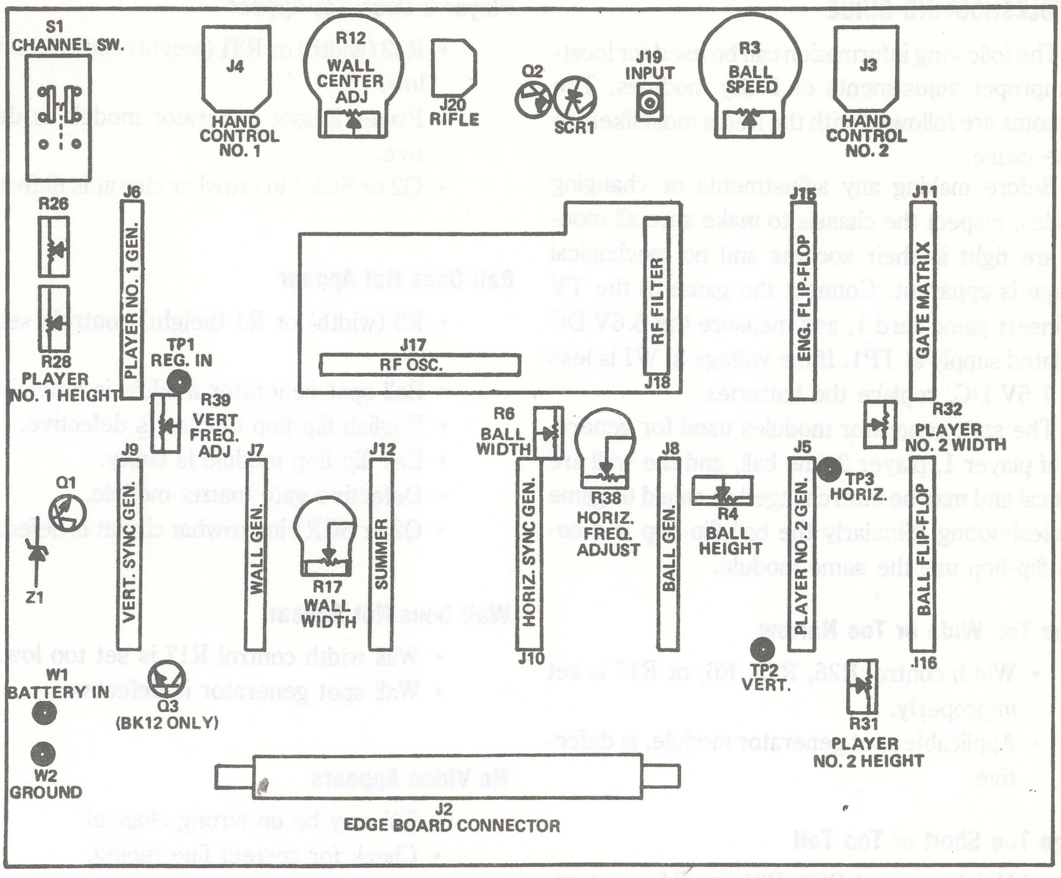



Fig. 3-49. Service adjustment locations for the 1TL200.

6. Adjust player 1 height control R28 for the proper height of player 1.
7. Adjust player 2 width control R32 for the proper width of player 2.
8. Adjust player 2 height control R31 for the proper height of player 2.
9. Depress both reset buttons and release. The ball will drift to the center of the screen.
10. Turn centering control R12 so that the wall is not on top of the ball.
11. Adjust ball width control R6 for the proper ball width.
12. Adjust ball height control R4 for the proper ball height.
13. Turn centering control R12 so that the wall is at midpoint on the screen.

**TABLE 1 – SPOT SIZES**

| TV Tube Size | Wall Width | Player | | Ball | |
|---|---|---|---|---|---|
| | | Width | Height | Width | Height |
| 25 in. | ¾ in. | 1¼ in. | 1¼ in. | 1 in. | 1 in. |
| 23 in. | 11/16 in. | 1 1/8 in. | 1 1/8 in. | 7/8 in. | 7/8 in. |
| 21 in. | 5/8 in. | 1 in. | 1 in. | 7/8 in. | 7/8 in. |
| 19 in. | 9/16 in. | 15/16 in. | 15/16 in. | ¾ in. | ¾ in. |
| 16 in. | ½ in. | 13/16 in. | 13/16 in. | 5/8 in. | 5/8 in. |
| 14 in. | 7/16 in. | 11/16 in. | 11/16 in. | 9/16 in. | 9/16 in. |
| 12 in. | 3/8 in. | 5/8 in. | 5/8 in. | ½ in. | ½ in. |

**Game Card No. 1 Display**

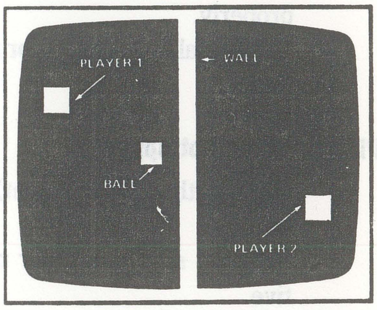



Fig. 3-50. Spot size information for the 1TL200.

## TROUBLESHOOTING GUIDE

The following information can be used for locating improper adjustments or faulty modules. The symptoms are followed with the items most likely to be the cause.

Before making any adjustments or changing modules, inspect the chassis to make sure all modules are tight in their sockets and no mechanical damage is apparent. Connect the game to the TV set, insert game card 1, and measure the 5.6V DC regulated supply at TP1. If the voltage at W1 is less than 7.5V DC, replace the batteries.

The spot generator modules used for generation of player 1, player 2, the ball, and the wall are identical and may be interchanged as an aid to game troubleshooting. Similarly the ball flip-flop and english flip-flop use the same module.

### Image Too Wide or Too Narrow

- Width control R26, R32, R6, or R17 is set improperly.
- Applicable spot generator module, is defective.

### Image Too Short or Too Tall

- Height control R28, R31, or R4 is set improperly.
- Applicable spot generator module is defective.

### Display Has Vertical Roll or Random Spots

- Vertical frequency control R39 is not set properly.
- Vertical sync generator module is defective.

### Display Tears Horizontally

- Horizontal frequency control R38 is not set properly.
- Horizontal sync generator module is defective.

### Player 1 Does Not Appear

- R26 (width) or R28 (height) controls set too low.
- Player 1 spot generator module is defective.
- Q1 or SCR1 in crowbar circuit is defective.

### Player 2 Does Not Appear

- R32 (width) or R31 (height) controls set too low.
- Player 2 spot generator module is defective.
- Q2 or SCR1 in crowbar circuit is defective.

### Ball Does Not Appear

- R6 (width) or R4 (height) controls set too low.
- Ball spot generator module is defective.
- English flip-flop module is defective.
- Ball flip-flop module is faulty.
- Defective gate matrix module.
- Q2 or SCR1 in crowbar circuit is defective.

### Wall Does Not Appear

- Wall width control R17 is set too low.
- Wall spot generator is defective.

### No Video Appears

- TV may be on wrong channel.
- Check for correct fine tuning.
- Antenna/game switch not in game position.
- Game cord is open or shorted.
- Antenna/game switch is defective.
- Voltage regulator transistor Q1 is defective.
- Horizontal sync generator module is defective.
- Vertical sync generator module is defective.
- Summer module is defective.
- RF circuits in master board faulty.

### Ball Movement Is Erratic or Drifts Slowly

- English flip-flop module is defective.
- Ball flip-flop module is defective.
- Ball spot generator is defective.

### Only Wall Appears on Screen

- Vertical sync generator is defective.

### Player or Ball Doesn't Disappear at Coincidence

- Gate matrix is defective.
- Q2 or SCR1 in crowbar circuit is defective.

**Player Not Movable Over Entire Screen**

- Player control unit is defective.
- Player spot generator module is defective.

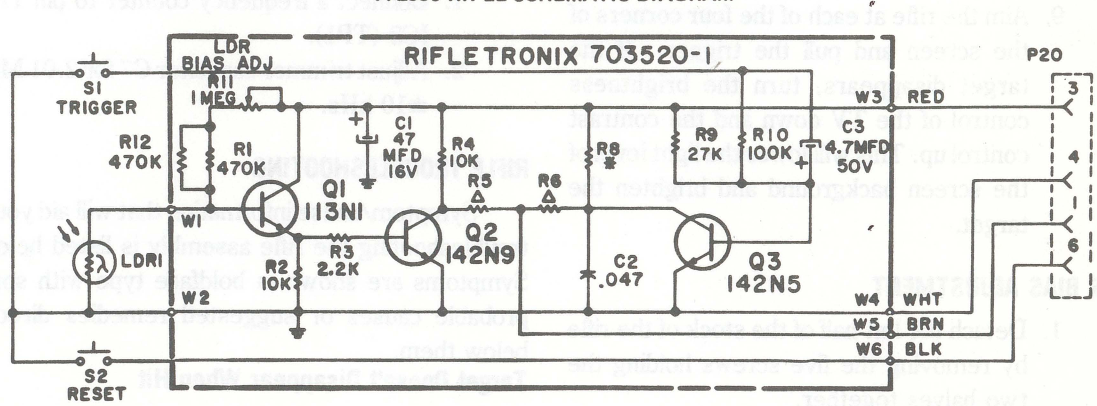
## RIFLE ACCESSORY DESCRIPTION

The rifle is well constructed and is completely safe. It is designed to extinguish a light or target that appears on the TV screen when either game card 9 or 10 is inserted into the master control unit. Since the rifle is sensitive to all light sources, it is important that the room lighting (lamps and sunlight) be adjusted to simulate normal light viewing conditions. A schematic and parts list for the rifle accessory unit is shown in Fig. 3-51.

## SIGHT ALIGNMENT

1. Set up the Odyssey unit as for other games.
2. Plug rifle cord P20 into the ACC (accessory) receptable on the back of the master control unit.
3. Insert game card 9 into the master control unit. If a white spot of light is not visible on the TV screen, cock the rifle by sliding the pump handle towards the trigger, then releasing it. Should the light still not be visible, rotate the player 2 vertical and horizontal controls until the light is in the center of the screen.
4. Stand about 6 feet from the TV screen and aim the rifle at the spot of light. See the illustration of how to line up the sights in Fig. 3-52.
5. Squeeze the trigger; the spot of light should disappear. Thus, the sights are correct. If the light does not disappear, continue cocking the rifle and pulling the trigger while moving closer to the screen.
6. If the aim is off in elevation, turn the screw adjustment of the rear sight. Rotate it clockwise to lower the muzzle or counterclockwise to raise the muzzle.

**1TL950 RIFLE SCHEMATIC DIAGRAM**




**703520-1 "RIFLETRONIX BOARD" REPLACEMENT PARTS LIST**

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | CAPACITORS | |
| C1 | Electrolytic, 47 mfd., 16V | 270109-5115 |
| C2 | Polyester, .047 mfd., 10%, 100V | 250581-4743 |
| C3 | Electrolytic, 4.7 mfd., 50V | 270109-5050 |
| | CONTROLS & SWITCHES | |
| R11 | 1 meg., LDR Bias Adjust | 220193-36 |
| S1 | Trigger Switch | 731984-1 |
| S2 | Reset Switch | 731985-1 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | SEMICONDUCTORS | |
| Q1 | NPN Silicon | 610113-1 |
| Q2 | NPN Silicon | 610142-9 |
| Q3 | NPN Silicon | 610142-5 |
| | MISCELLANEOUS | |
| LDR1 | Light Dependent Resistor | 230204-2 |
| | LDR Holder, Top | 142722-1 |
| | LDR Holder, Bottom | 142723-1 |
| | Wire Wrap Pin | 200460-3 |

Fig. 3-51. Accessory rifle schematic diagram and parts list for the 1TL200.

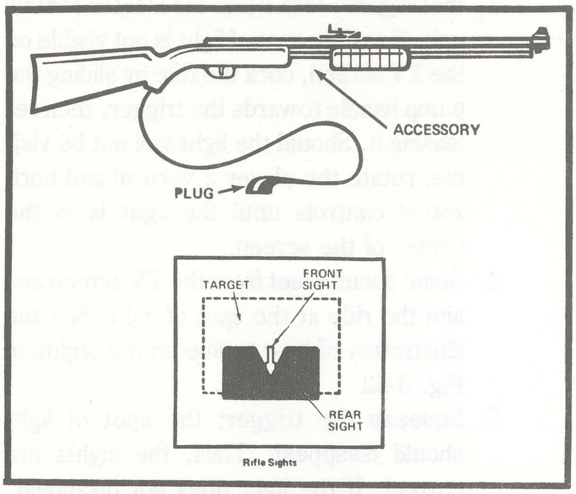



Fig. 3-52. 1TL950 rifle accessory with view of rifle sights.

7. If the aim is off in azimuth, loosen the clamp screw on the front sight and rotate the sight in the direction of error.
8. Once you have extinguished the light and are certain of your aim, return to a position of 6 feet from the TV screen and cock the rifle to reset the target.
9. Aim the rifle at each of the four corners of the screen and pull the trigger. If the target disappears, turn the brightness control of the TV down and the contrast control up. This will lower the light level of the screen background and brighten the target.

## LDR BIAS ADJUSTMENT

1. Detach the left half of the stock of the rifle by removing the five screws holding the two halves together.
2. Replace the two screws through the barrel and right half of the stock to hold it while testing.
3. Insure that the barrel lens is in place, clean, and not tilted.
4. Plug rifle cord P20 into the ACC jack on the master control unit.
5. Insert game card 9 into the slot.
6. Locate player 2 on the screen.
7. Rotate the brightness control of the TV until the background level is natural gray.
8. Rotate LDR bias adjust R11 to its fully clockwise position.
9. Aim the gun point-blank at the gray area (not at the spot) and pull the trigger. Player 2 spots should remain lit.
10. While pumping the trigger, slowly rotate R11 counterclockwise until player 2 spot disappears. Allow at least 2 seconds between triggering. If the spot never disappears at any setting of R11, replace the gun.
11. Press the player 2 reset button.
12. Adjust the TV brightness and contrast controls for a white player 2 spot on a dark background.
13. To check for correct LDR bias adjustment, simulate ambient light surroundings.
14. Hold the gun 6 feet from the TV screen, aim at the background and pull the trigger. The spot should remain lit.
15. Carefully aim at the spot and pull the trigger. The spot should now disappear.

## 702553-1 2 MHz OSCILLATOR ADJUSTMENT

1. Connect a frequency counter to pin 17 of IC3 (TP1).
2. Adjust trimmer capacitor C7 for 2.01 MHz ±10 kHz.

## RIFLE TROUBLESHOOTING

Symptom/cause information that will aid you in troubleshooting the rifle assembly is listed below. Symptoms are shown in boldface type with some probable causes or suggested remedies directly below them.

### Target Doesn't Disappear When Hit

- Check the lens in the end of the barrel for dirt or scratches.
- Make sure lens is not tilted. Replace lens if necessary.
- Check accuracy of gun sights. Adjust sights as required.
- Perform the *LDR Bias Adjustment*.
- Master control unit is defective.
- Rifle is defective.

### Target Disappears Even When Missed

- Adjust setting of the brightness and contrast controls on TV set. The brightness should be turned down and the contrast up.

- Perform *LDR Bias Adjustment.*
- Master control unit or rifle may be defective.

### SCHEMATICS & PARTS LISTS

The complete schematic diagram for the 1TL200 BK12 is shown in Fig. 3-53, covering four pages. The schematic for the 1TL200 BLAK is shown in Fig. 3-54, also covering four pages. Parts lists for both versions are in Fig. 3-55. When ordering replacement parts state the model number, schematic symbol (if applicable), description, and part number of the desired item. A list of replacement plug-in modules and their part numbers for these models is shown in Fig. 3-56.

## T991 TV CHASSIS WITH BUILT-IN ODYSSEY

Magnavox has combined video games from the Odyssey with the T991 chassis to provide the first color TV with built-in Odyssey. The advantages of incorporating the game circuitry as part of the TV are many. By driving the video output stages directly, the players and the ball can be different colors without complex chroma circuitry. Alignment is not required since there is no RF oscillator. The tuner, IF amplifiers, and video amplifiers are not used. The TV volume control can change the loudness of the sound.

Model BG4305 comes with two removable control handles on extension cables. Both handles have a rotary control that moves the vertical position of its respective player. The left-hand control has a pushbutton used to reset the score at the end of the game. The button on the right-hand control selects the desired game.

Three different game formats are available with two skill levels for each game. When the TV is turned on, and the game/TV switch is set to game, the screen will display one of the three formats. The pushbutton on the right-hand control selects the game to be played and the skill level. When a game is first selected, the ball speed is slow and the players are small. When the button on the right-hand control is pressed again, the game stays the same, but the ball speed doubles as does the size of the players.

If the game on the screen is tennis, Fig. 3-57, the four succeeding button actuations select hockey, Fig. 3-53, and smash, Fig. 3-59. That is, there are two actuations per game. Each game is displayed first as slow ball, small players; then fast ball, large players. The sixth press of the button returns the sequence to tennis, slow ball, small players.

Chip IC3, shown in Fig. 3-60, is an integrated circuit with large-scale integration, or LSI. This single chip contains the game logic, sync generators, and sound generator. IC3 is the same LSI chip as is used in the Odyssey 300. The LSI chip's separate outputs for the ball, left player, and walls and score, coupled with the T991's external color matrixing, allow the addition of color without chroma circuits.

The output of the ball generator is inverted through Q6, coupled through parallel resistors and isolating diodes, and applied to the emitter of the green and red output transistors on the RGB module. This means that only the green and red CRT grids respond to the ball signal, and the ball will appear yellow on the screen.

The right player output is connected to the red output transistor, producing a red player on the screen. The left player signal is applied to the blue output transistor, making it blue. The wall and score outputs are applied to TP14, which is the video input to the RGB module. That signal is applied to all three output transistors equally, providing white walls and scores.

Model BG4305 incorporates automatic english, meaning the angle of ball travel from the player is determined by the spot on the player that the ball strikes. Both players are divided into four sections as illustrated in Fig. 3-61. Striking the bottom quadrant of the player will cause the ball to rebound toward the bottom of the screen. When the ball hits the top of the player, it will rebound toward the top of the screen.

Striking the two inner sections of the player will cause the ball to rebound at a 20° angle. The outer areas cause a 40° angle. The english cannot be controlled after the ball leaves the player. It can be controlled before the ball strikes the players, by positioning the player so the ball strikes it in the desired area.

Three different frequencies are used for tone of the ball sound. A different tone is used for when the ball strikes a player, rebounds from a wall, or

Continued on page 140.

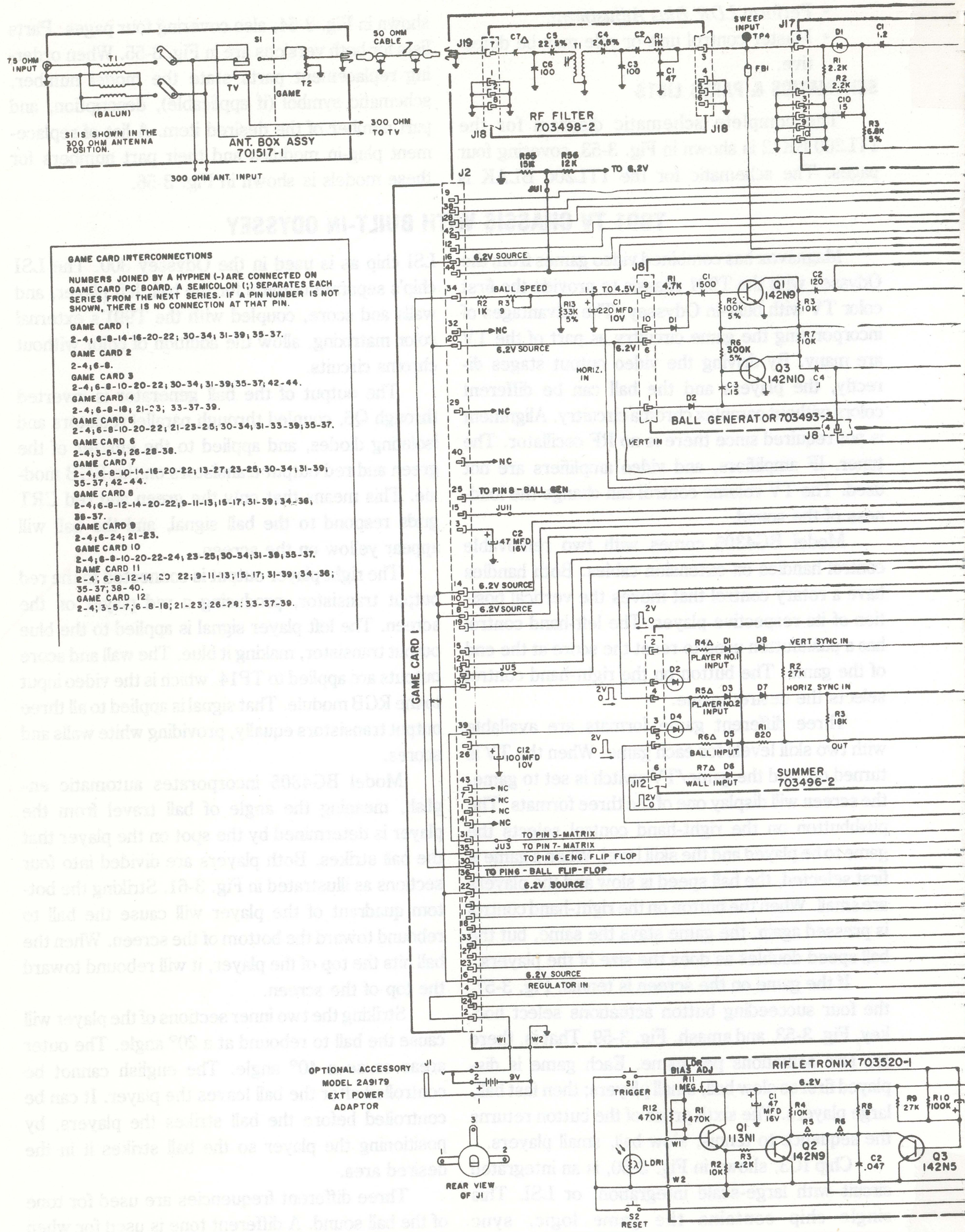



Fig. 3-53. Schematic diagram of the 1TL200 BK12 (sheet 1 of 4).

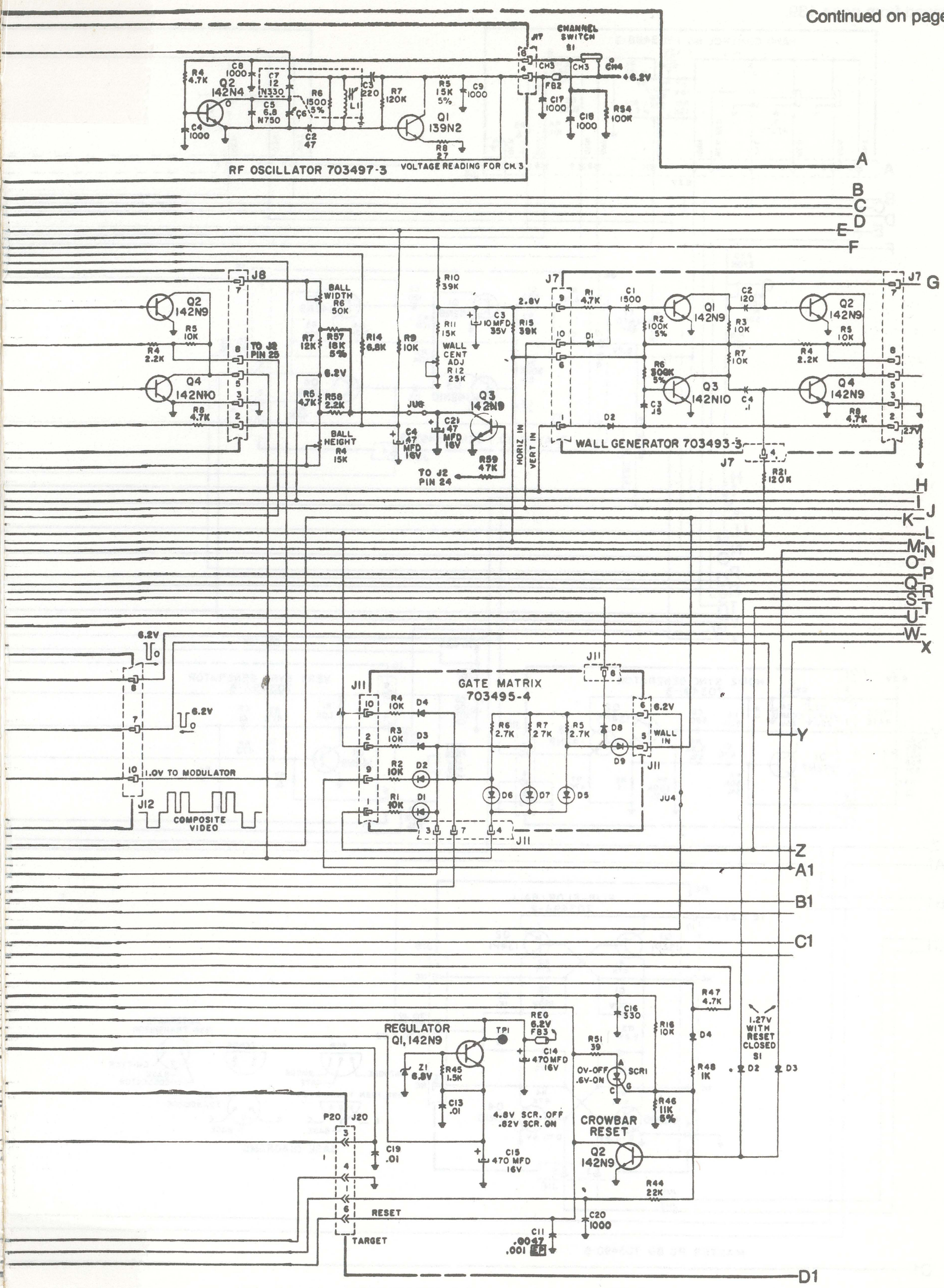



Fig. 3-53. (Sheet 2 of 4.)

Continued from page 139.

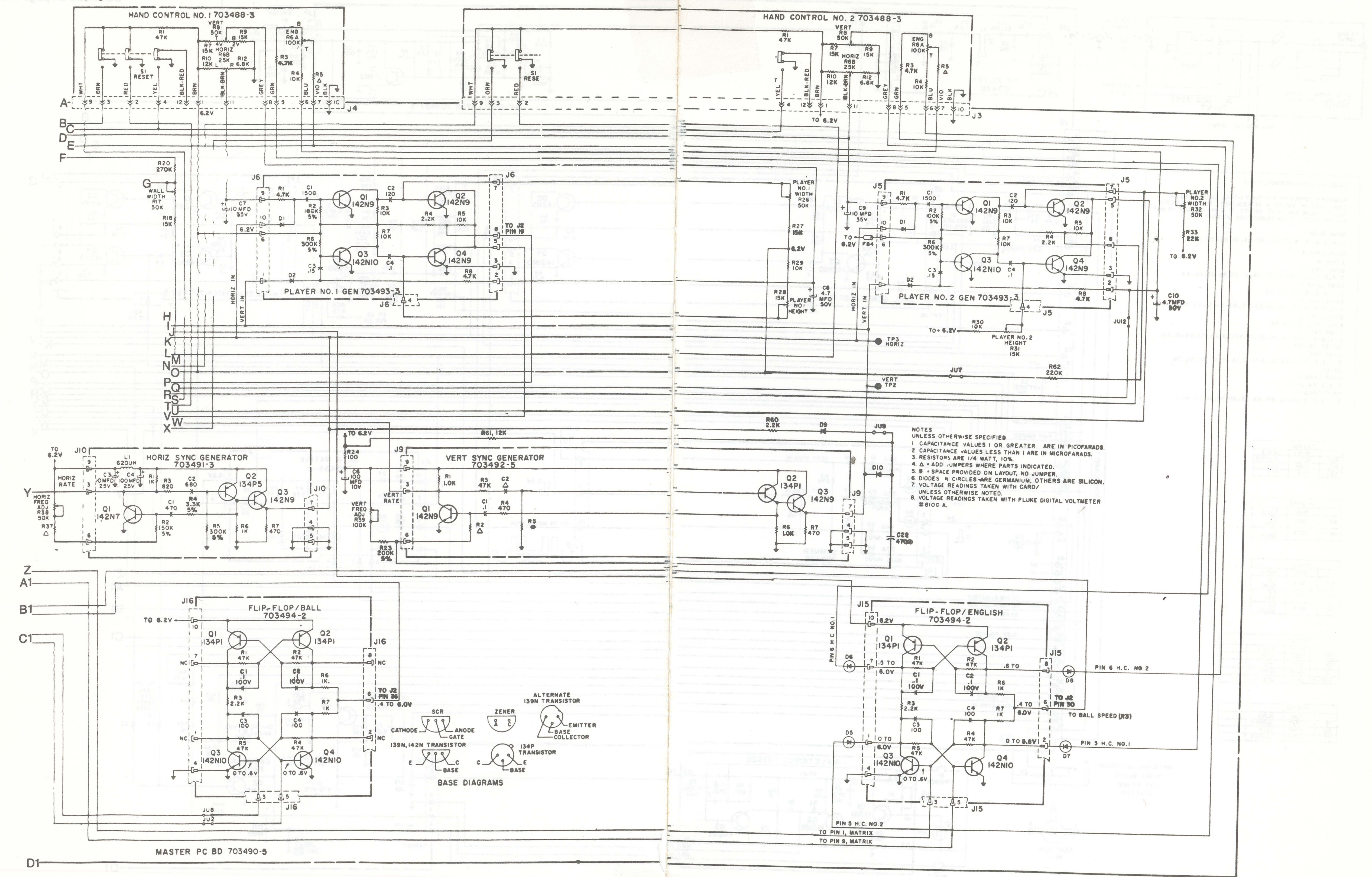
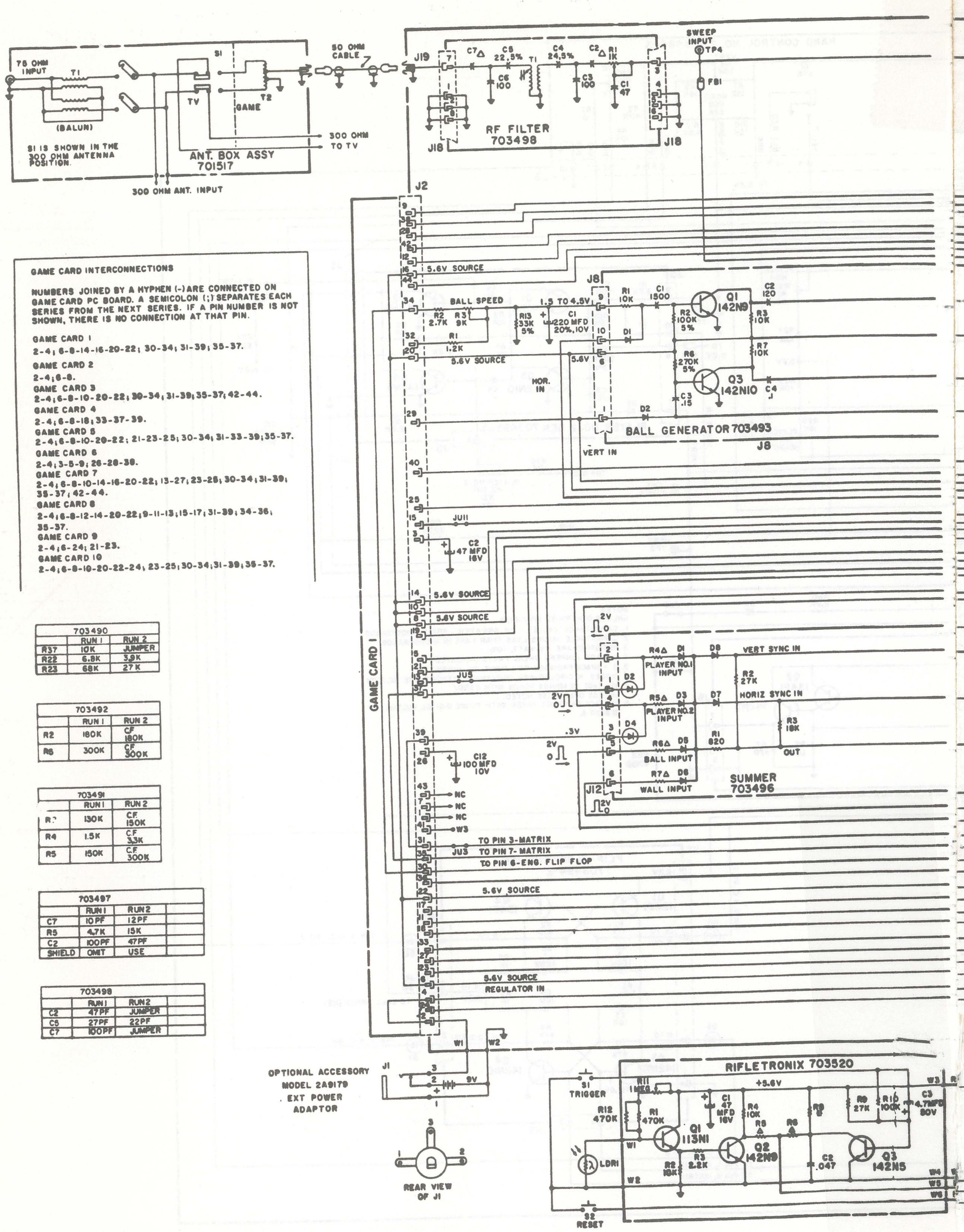



Fig. 3-53. Schematic diagram of the 1TL200 BK12 (sheet 3 of 4).

Fig. 3-53. (Sheet 4 of 4.)

Continued on page 144.




GAME CARD INTERCONNECTIONS

NUMBERS JOINED BY A HYPHEN (-) ARE CONNECTED ON GAME CARD PC BOARD. A SEMICOLON (;) SEPARATES EACH SERIES FROM THE NEXT SERIES. IF A PIN NUMBER IS NOT SHOWN, THERE IS NO CONNECTION AT THAT PIN.

GAME CARD 1
2-4; 6-8-14-16-20-22; 30-34; 31-39; 35-37.

GAME CARD 2
2-4; 6-8.

GAME CARD 3
2-4; 6-8-10-20-22; 30-34, 31-39; 35-37; 42-44.

GAME CARD 4
2-4; 6-8-18; 33-37-39.

GAME CARD 5
2-4; 6-8-10-20-22; 21-23-25; 30-34; 31-33-39; 35-37.

GAME CARD 6
2-4; 3-5-9; 26-28-30.

GAME CARD 7
2-4; 6-8-10-14-16-20-22; 13-27; 23-25; 30-34; 31-39; 35-37; 42-44.

GAME CARD 8
2-4; 6-8-12-14-20-22; 9-11-13; 15-17; 31-39; 34-36; 35-37.

GAME CARD 9
2-4; 6-24; 21-23.

GAME CARD 10
2-4; 6-8-10-20-22-24, 23-25; 30-34; 31-39; 35-37.

| 703490 | | |
|---|---|---|
| | RUN 1 | RUN 2 |
| R37 | 10K | JUMPER |
| R22 | 6.8K | 3.9K |
| R23 | 68K | 27K |

| 703492 | | |
|---|---|---|
| | RUN 1 | RUN 2 |
| R2 | 180K | CF 180K |
| R6 | 300K | CF 300K |

| 703491 | | |
|---|---|---|
| | RUN 1 | RUN 2 |
| R? | 130K | C.F. 150K |
| R4 | 1.5K | C.F. 3.3K |
| R5 | 150K | C.F. 300K |

| 703497 | | | |
|---|---|---|---|
| | RUN 1 | RUN 2 | |
| C7 | 10PF | 12PF | |
| R5 | 4.7K | 15K | |
| C2 | 100PF | 47PF | |
| SHIELD | OMIT | USE | |

| 703498 | | | |
|---|---|---|---|
| | RUN 1 | RUN 2 | |
| C2 | 47PF | JUMPER | |
| C5 | 27PF | 22PF | |
| C7 | 100PF | JUMPER | |

Fig. 3-54. Schematic diagram of the 1TL200 BLAK (sheet 1 of 4).

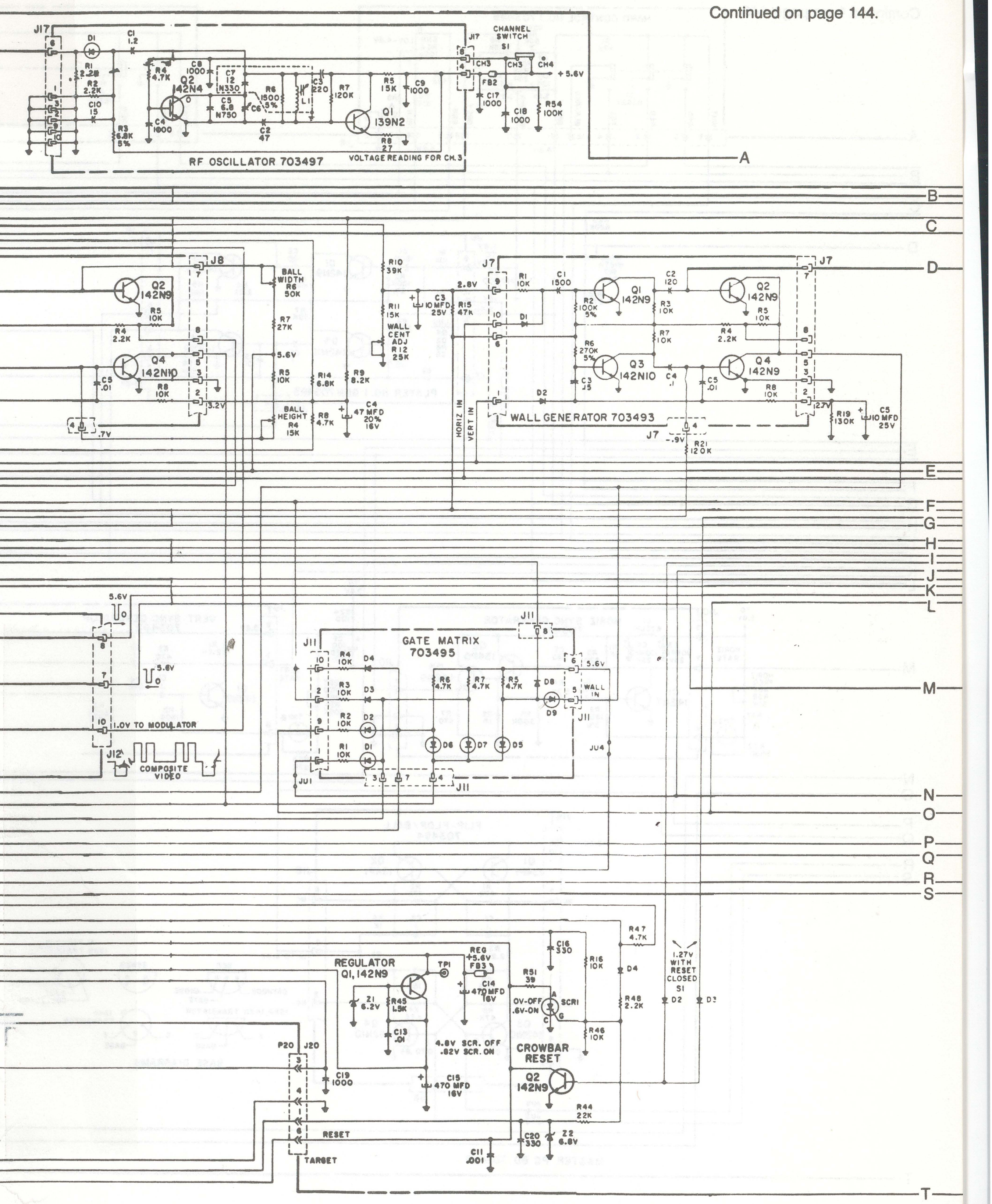



Fig. 3-54. (Sheet 2 of 4.)

Continued from page 143.

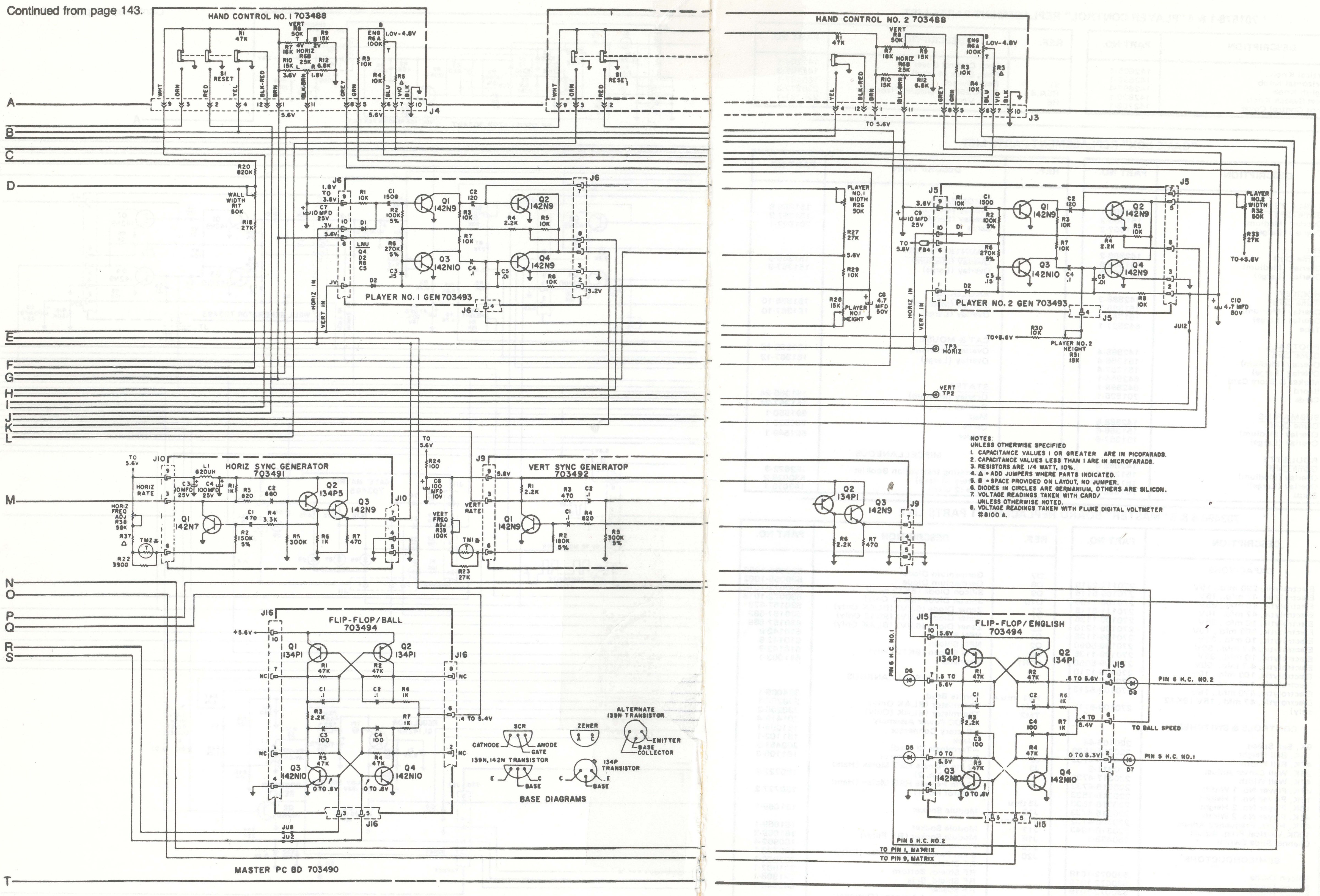



Fig. 3-54. Schematic diagram of the 1TL200 BLAK (sheet 3 of 4).

Fig. 3-54. (Sheet 4 of 4.)

## 701578-1 & 4 "PLAYER CONTROL" REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | Vertical Knob | 142695-1 |
| | Horizontal Knob | 142696-1 |
| | English Knob | 142697-4 |
| | Reset Switch Knob | 142828-1 |
| | Front Control Cover | 142706-1 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | Back Control Cover | 142705-1 |
| | Feet, Black (4 used) | 141737-3 |
| S1 | Reset Switch | 160487-1 |
| R6A,B | 100K/25K, English/Horizontal | 220272-3 |
| R8 | 50K, Vertical | 220281-1 |

## "GAME BOX" REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | TABLE TENNIS | |
| | Game Card | 142888-1 |
| | Overlay (Medium) | 151366-2 |
| | Overlay (Large) | 151367-2 |
| | SKI | |
| | Game Card | 142888-2 |
| | Overlay (Medium) | 151366-5 |
| | Overlay (Large) | 151367-5 |
| | HOCKEY | |
| | Game Card | 142888-3 |
| | Overlay (Medium) | 151366-3 |
| | Overlay (Large) | 151367-3 |
| | Tape | 642897-1 |
| | FOOTBALL | |
| | Game Card | 142888-4 |
| | Overlay (Medium) | 151366-4 |
| | Overlay (Large) | 151367-4 |
| | Marker & Score Card | 642964-1 |
| | Board | 642898-1 |
| | Cards | 701525-1 |
| | SUBMARINE | |
| | Game Card | 142888-5 |
| | Overlay (Medium) | 151366-6 |
| | Overlay (Large) | 151367-6 |
| | ROULETTE | |
| | Game Card | 142888-6 |
| | Overlay (Medium) | 151366-11 |
| | Overlay (Large) | 151367-11 |
| | Chips | 701528-1 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | SIMON SAYS | |
| | Overlay (Medium) | 151366-8 |
| | Overlay (Large) | 151367-8 |
| | Cards | 701527-1 |
| | HAUNTED HOUSE | |
| | Overlay (Medium) | 151366-9 |
| | Overlay (Large) | 151367-9 |
| | ANOLOGIC | |
| | Overlay (Medium) | 151366-10 |
| | Overlay (Large) | 151367-10 |
| | CAT & MOUSE | |
| | Overlay (Medium) | 151366-12 |
| | Overlay (Large) | 151367-12 |
| | STATES | |
| | Overlay (Medium) | 151366-24 |
| | Overlay (Large) | 151367-24 |
| | Map | 591550-1 |
| | Cards | 701526-1 |
| | Folder | 591549-1 |
| | MISCELLANEOUS | |
| | Operating Instruction Booklet | IB2622-3 |
| | Battery (6 used) | 530078-2 |
| | Dice (2 used) | 143018-1 |

## 703490-4 & 5 "MASTER" BOARD REPLACEMENT PARTS LIST

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | CAPACITORS | |
| C1 | Electrolytic, 220 mfd., 10V | 270111-2210 |
| C2 | Electrolytic, 47 mfd., 16V | 270109-5115 |
| C3 | Electrolytic, 10 mfd., 35V | 270109-1135 |
| C4 | Electrolytic, 47 mfd., 16V | 270111-5115 |
| C5 | Electrolytic, 10 mfd., 35V | 270109-1135 |
| C6 | Electrolytic, 100 mfd., 10V | 270109-1210 |
| C7 | Electrolytic, 10 mfd., 35V | 270109-1135 |
| C8 | Electrolytic, 4.7 mfd., 50V | 270109-5050 |
| C9 | Electrolytic, 10 mfd., 35V | 270109-1135 |
| C10 | Electrolytic, 4.7 mfd., 50V | 270109-5050 |
| C12 | Electrolytic, 100 mfd., 10V | 270109-1210 |
| C14 | Electrolytic, 470 mfd., 16V | 270109-5215 |
| C15 | Electrolytic, 470 mfd., 16V | 270109-5215 |
| C21 | Electrolytic, 47 mfd., 16V (BK12 only) | 270109-5115 |
| | CONTROLS & SWITCHES | |
| R3 | 9K, Ball Speed | 220166-44 |
| R4 | 15K, Ball Height | 220316-1533 |
| R6 | 47K, Ball Width | 220316-4733 |
| R12 | 25K, Wall Center Adjust | 220311-3 |
| R17 | 47K, Wall Width | 220317-4732 |
| R26 | 47K, Player No. 1 Width | 220316-4733 |
| R28 | 15K, Player No. 1 Height | 220316-1533 |
| R31 | 15K, Player No. 2 Height | 220316-1533 |
| R32 | 47K, Player No. 2 Width | 220316-4733 |
| R38 | 47K, Horiz. Frequency Adjust | 220300-4732 |
| R39 | 100K, Vertical Freq. Adjust | 220316-1043 |
| S1 | Channel Slide Switch | 160498-1 |
| | SEMICONDUCTORS | |
| D2 | Silicon Diode | 530072-1018 |
| D3 | Silicon Diode | 530072-1018 |
| D4 | Silicon Diode | 530072-1018 |
| D5 | Germanium Diode | 530065-1002 |
| D6 | Germanium Diode | 530065-1002 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| D7 | Germanium Diode | 530065-1002 |
| D8 | Germanium Diode | 530065-1002 |
| D9 | Silicon Diode (BK12 only) | 530072-1018 |
| D10 | Silicon Diode (BK12 Only) | 530072-1018 |
| Z1 | Zener Diode (6.2V) (BLAK Only) | 530157-629 |
| Z1 | Zener Diode (6.8V) (BK12 Only) | 530157-689 |
| Z2 | Zener Diode (6.8V) (BLAK Only) | 530157-689 |
| Q1 | NPN Silicon | 610142-9 |
| Q2 | NPN Silicon | 610142-9 |
| Q3 | NPN Silicon (BK12 Only) | 610142-9 |
| SCR1 | Thyristor | 611003-1 |
| | MISCELLANEOUS | |
| FB1 thru 4 | Ferrite Bead | 364005-1 |
| TM1 | Thermistor (BLAK Only) | 230205-1 |
| TM2 | Thermistor (BLAK (Only) | 230205-2 |
| J1 | AC/DC Power Assembly | 701479-4 |
| | —Battery Connector | 181096-1 |
| | —Jack | 181102-1 |
| | —Terminals (2 used) | 200451-2 |
| J2 | Edge Board Connector | 181105-3 |
| J3 | 12 Pin Female HSG Molex (Hand Control No. 2) | 180727-2 |
| J4 | 12 Pin Female HSG Molex (Hand Control No. 1) | 180727-2 |
| J5 thru J12 | Module Socket | 181069-1 |
| J15 thru J17 | Module Socket | 181069-1 |
| J18 | Module Socket (RF Filter) | 181069-2 |
| J19 | Phono Coax Socket | 180902-4 |
| J20 | 6 Pin Female HSG Molex (Rifle) | 180732-1 |
| | RF Shield Top | 731906-1 |
| | RF Shield, Bottom | 731907-1 |
| | RF Shield, Side | 731908-1 |
| | RF Spacer | 642940-1 |
| | AC External Adaptor (Optional Accessory) | 2A9179 |

Fig. 3-55. Part list for the 1TL200.

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | Horizontal Sync Generator Module | 703491-3 |
| | Vertical Sync Generator Module (BLAK) | 703492-3 |
| | Vertical Sync Generator Module (BK12) | 703492-5 |
| | Player No. 1 Generator Module (BLAK) | 703493-2 |
| | Player No. 1 Generator Module (BK12) | 703493-3 |
| | Player No. 2 Generator Module (BLAK) | 703493-2 |
| | Player No. 2 Generator Module (BK12) | 703493-3 |
| | Ball Generator Module (BLAK) | 703493-2 |
| | Ball Generator Module (BK12) | 703493-3 |
| | Wall Generator Module (BLAK) | 703493-2 |
| | Wall Generator Module (BK12) | 703493-3 |
| | Flip-Flop/English Module | 703494-2 |
| | Flip-Flop/Ball Module | 703494-2 |
| | Gate Matrix Module (BLAK) | 703495-2 |
| | Gate Matrix Module (BK12) | 703495-4 |
| | Summer Module | 703496-2 |
| | RF Oscillator Module | 703497-3 |
| | RF Filter Module | 703498-2 |
| | Hand Control No. 1 & 2 Module (BLAK) | 703488-2 |
| | Hand Control No. 1 & 2 Module (BK12) | 703488-3 |

Fig. 3-56. Circuit module part numbers for the 1TL200 BK12 and BLAK.

scores. The sound output is applied to the sound module through the TV volume control; therefore, loudness may be varied.

Another feature is on-screen digital scoring. When the ball leaves the screen, the scoring circuitry, in the LSI chip determines which player scored the point. The respective scores are displayed in the upper-center portion of the playing court. When one player reaches 15, the game stops and must be reset with the button on the left-hand control.

Both horizontal and vertical sync pulses are generated within IC3. These pulses are used inside the LSI chip to generate the other signals. The same pulses are sent to TP10, where they are coupled to the TV's sync separator.

## Game Select Block Diagram

Chips IC1 and IC2, shown in Fig. 3-62, allow the game formats and the skill levels to be selected in sequence by a single pushbutton. Tennis, hockey,

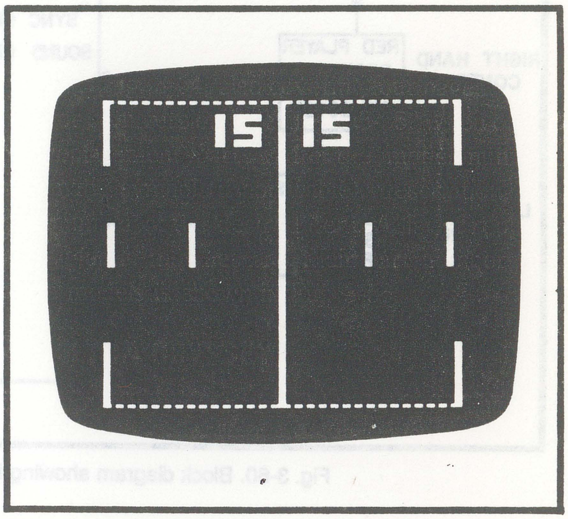



Fig. 3-58. Hockey display on the BG4305.

and smash, each with two skill levels, are selected by switch S602 on the right-hand control.

Starting the game select sequence with tennis—slow ball, small player—all three outputs of IC1 are zeros. Pin 9 of IC1 supplies a *zero* to both

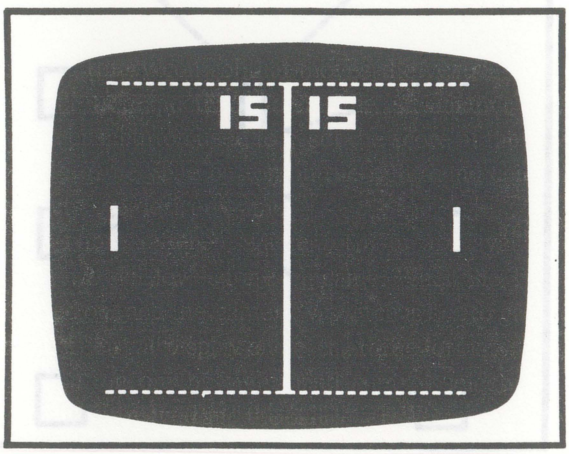



Fig. 3-57. Tennis format display for the BG4305 19-inch receiver.

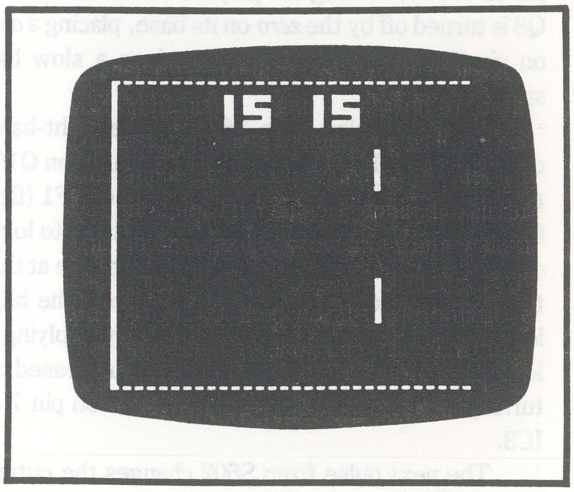



Fig. 3-59. Smash display on the BG4305.

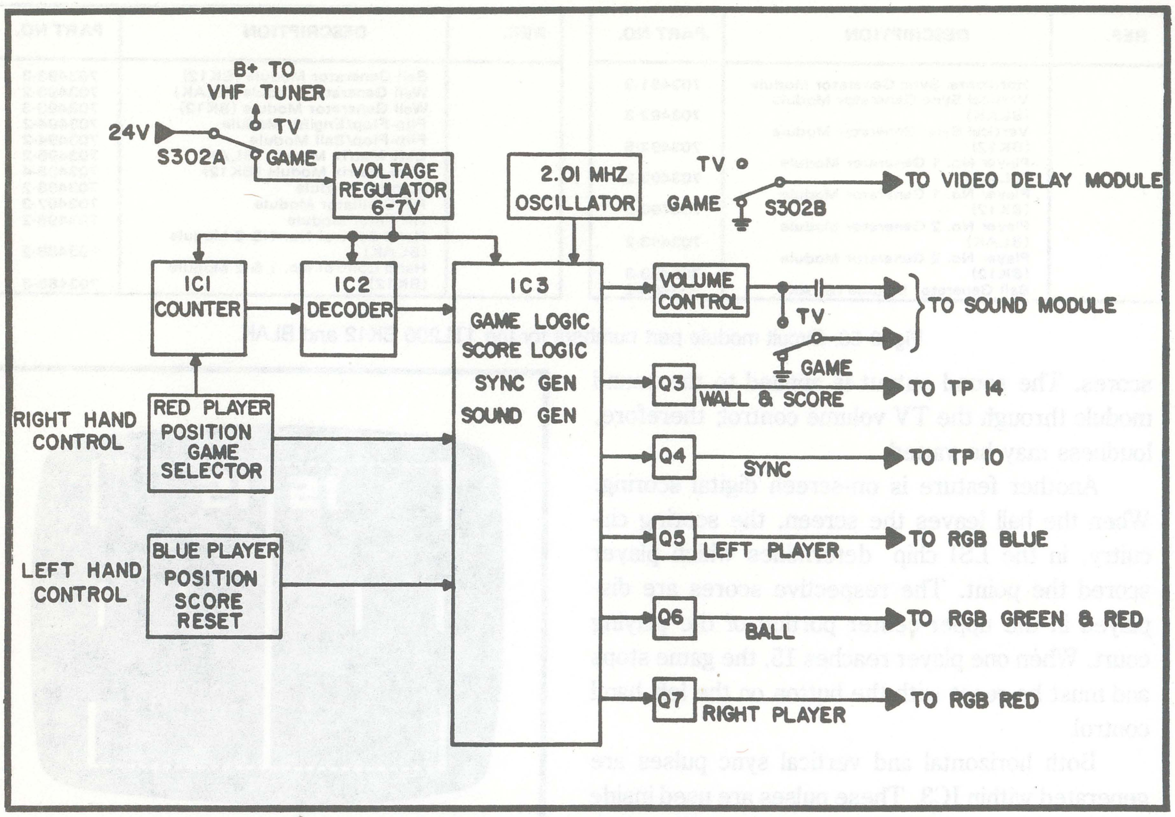



Fig. 3-60. Block diagram showing input and output circuits of game chip IC3.

inputs of NAND gate B of IC2, producing a *one* at its output. Pin 11 of IC1 provides a *zero* at its output.

The *one* outputs of gates A and B are coupled into NAND gate C, producing a *zero* at its output. This *zero* grounds pin 20 of IC3, enabling the tennis game logic.

The *zero* on pin 12 of IC1 is coupled directly to pin 13 of IC3, making the players small. Transistor Q8 is turned off by the *zero* on its base, placing a *one* on pin 7 of IC3. The *one* determines a slow ball speed.

The first pulse from S602 on the right-hand control turns off transistor Q2, which turns on Q10, grounding pin 1 of IC1 momentarily. Q of FF1 (flip-flop 1) goes low, changing the level of pin 12 to logic *one*. The levels of pins 11 and 9 do not change at this time, and the tennis logic is still enabled. The high level of pin 12 halves the player size by applying a logic *one* to pin 13 of IC3. Ball speed is increased by turning on Q8, which places a logic *zero* on pin 7 of IC3.

The next pulse from S602 changes the output of FF1, $\overline{Q}$, back to high, making pin 12 low. FF2 goes low, making pin 11 logic *one*. With a logic *one* applied to both inputs of NAND gate A, its output goes low. This logic *zero* is provided to pin 21 of IC3,

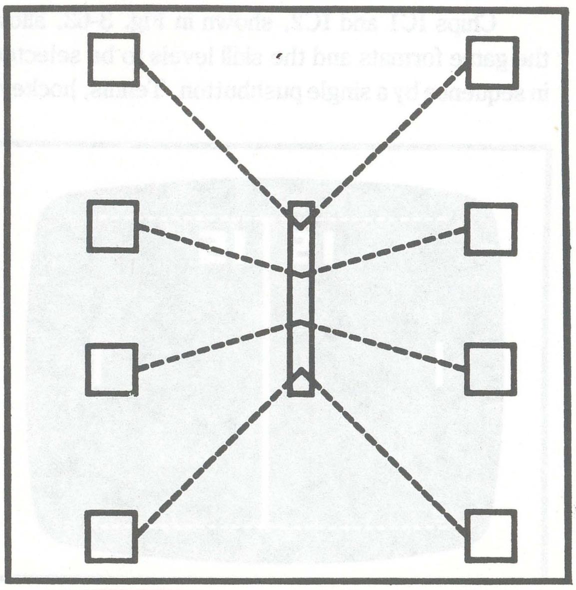


Fig. 3-61. Automatic english of the ball when striking the various portions of a player.

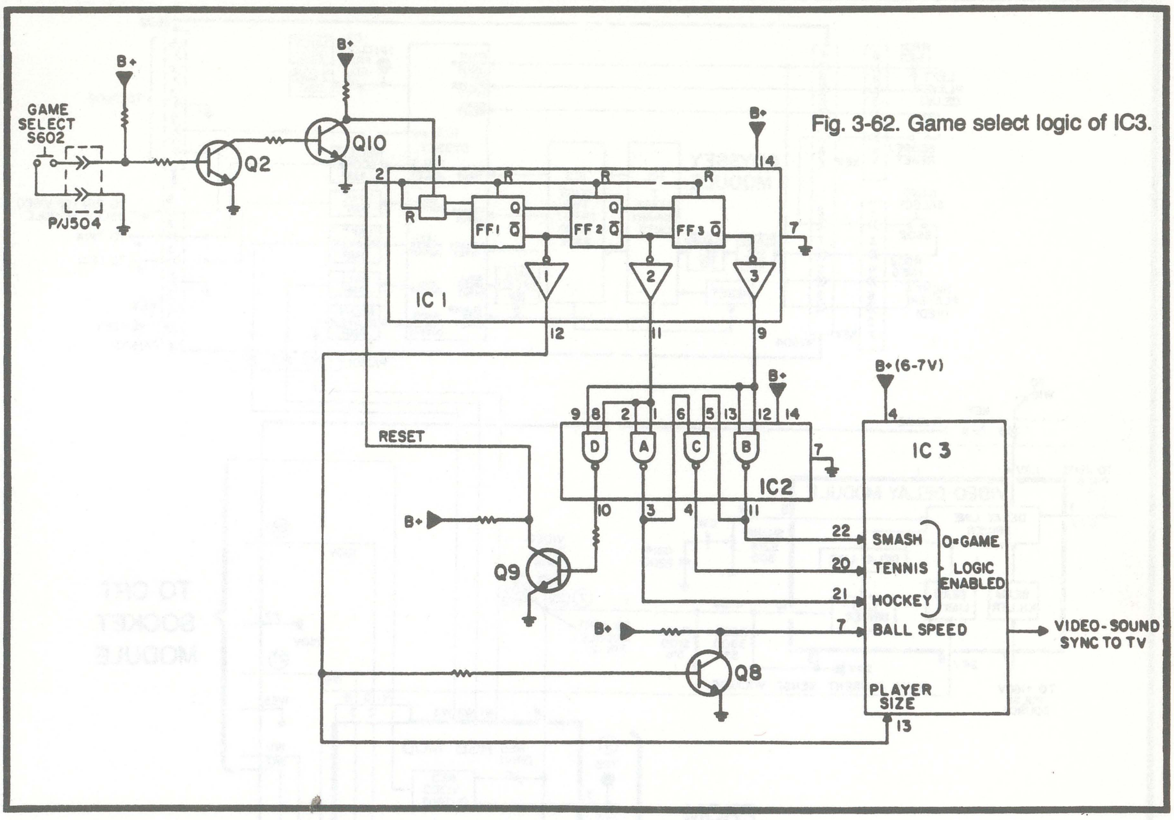


Fig. 3-62. Game select logic of IC3.

enabling the hockey logic, and to one input of NAND gate C. With a logic *one* and a logic *zero* at its inputs, the output of NAND gate C goes high, shutting off the tennis logic at pin 20 of IC3. The output of IC3 is now hockey, slow ball, smaller players.

The third pulse into IC1 changes pin 12 to logic *one*, providing a logic *one* to pin 13 of IC3 and a logic *zero* to pin 7 of IC3. The ball speed is fast, the player size is large, and the game is still hockey.

The next press of the button changes all three flip-flops in IC1. FF1 goes high, making pin 12 low. FF2 goes high, making pin 11 low, and causing FF3 to go low. The low on FF3 makes pin 9 go high.

NAND gate B now has logic *one* applied to its inputs, and its output goes to *zero*. This logic *zero* is supplied to pin 22 of IC3, enabling the smash logic. Pin 5 of IC2 is also *zero*, keeping the output of gate C high. NAND gate A now has logic *zero* on its inputs and *one* for an output, disabling the hockey logic. Since pin 12 of IC1 is low, the ball speed is slow, and the players are small.

Pressing the button a fifth time changes the state of pin 12, making the ball speed fast and the players large. The game is still smash.

The sixth and final press of the button makes pin 12 low and pin 11 high. Pin 9 remains high. The logic *one*s from pins 9 and 11 are applied to NAND gate D of IC2. This action causes a *zero* at gate D's output, turning Q9 off. Q9 applies a pulse to pin 2 of IC1, resetting all the flip-flops to the start position, with pins 9, 11, and 12 low.

## Servicing the BG4305

The BG4305 incorporates a standard 19-inch T991 chassis, except for the RGB module. A special RGB module, part number 703665-4, with a connector for the game module is used. All game logic circuitry is contained on one replaceable, plug-in module, part number 702553-1. An isolation transformer is also unique to this chassis. A partial schematic of the BG4305 is shown in Fig. 3-63. A detailed schematic of the 702553-1 game module is shown in Fig. 3-64. The PC board diagram and parts list for this plug-in module is shown in Fig. 3-65.

Servicing the BG4305 should always begin with some basic checks. Make sure the TV/game switch is in the desired position. Ensure that the player control units are plugged all the way into their re-

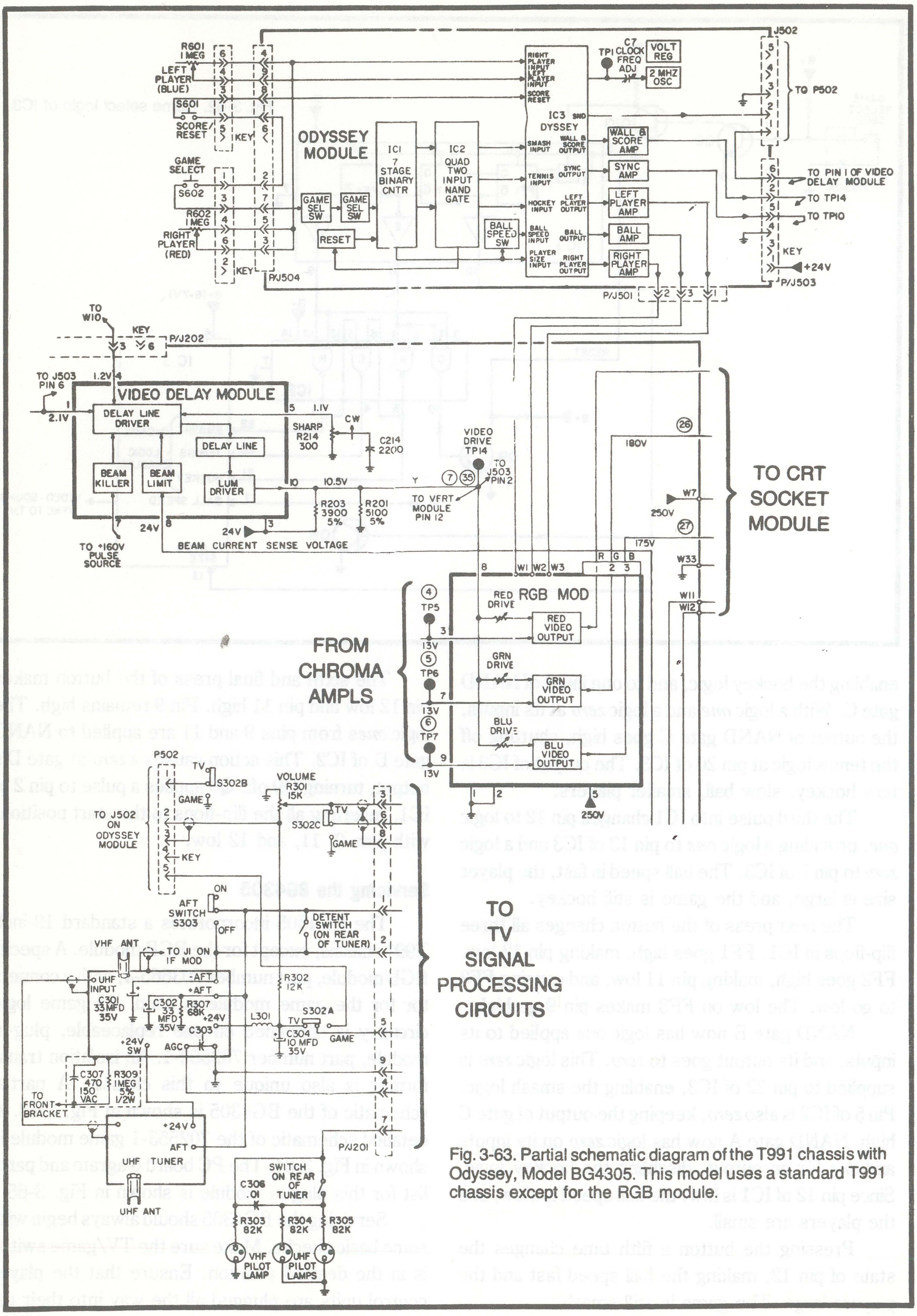
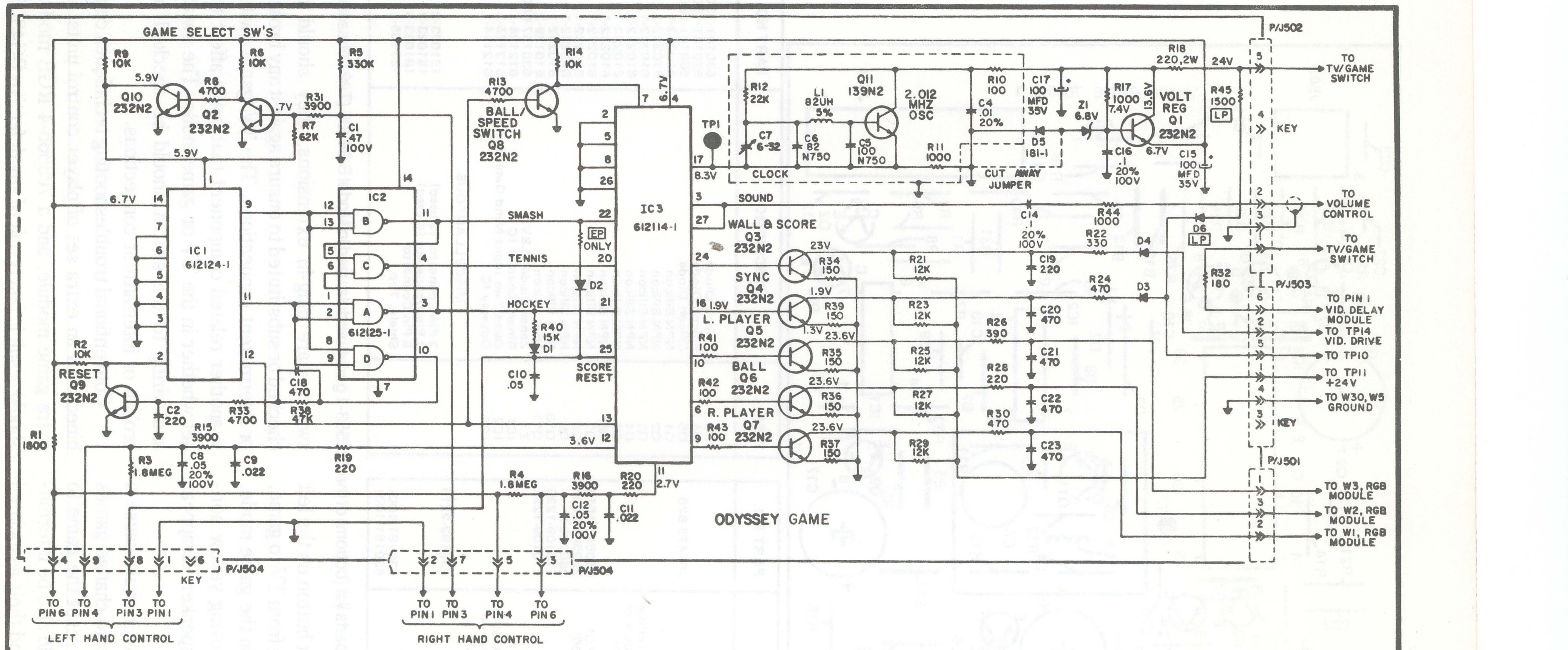



Fig. 3-63. Partial schematic diagram of the T991 chassis with Odyssey, Model BG4305. This model uses a standard T991 chassis except for the RGB module.




## WARNING

**Magnavox Consumer Electronics Company is committed to marketing safe products which meet or exceed applicable safety standards of industry, government agencies and independent laboratories. It therefore uses parts in its products designed for maximum safety, reliability, and performance.**

**In order to maintain these high standards, all parts must be replaced by those having identical specifications.**

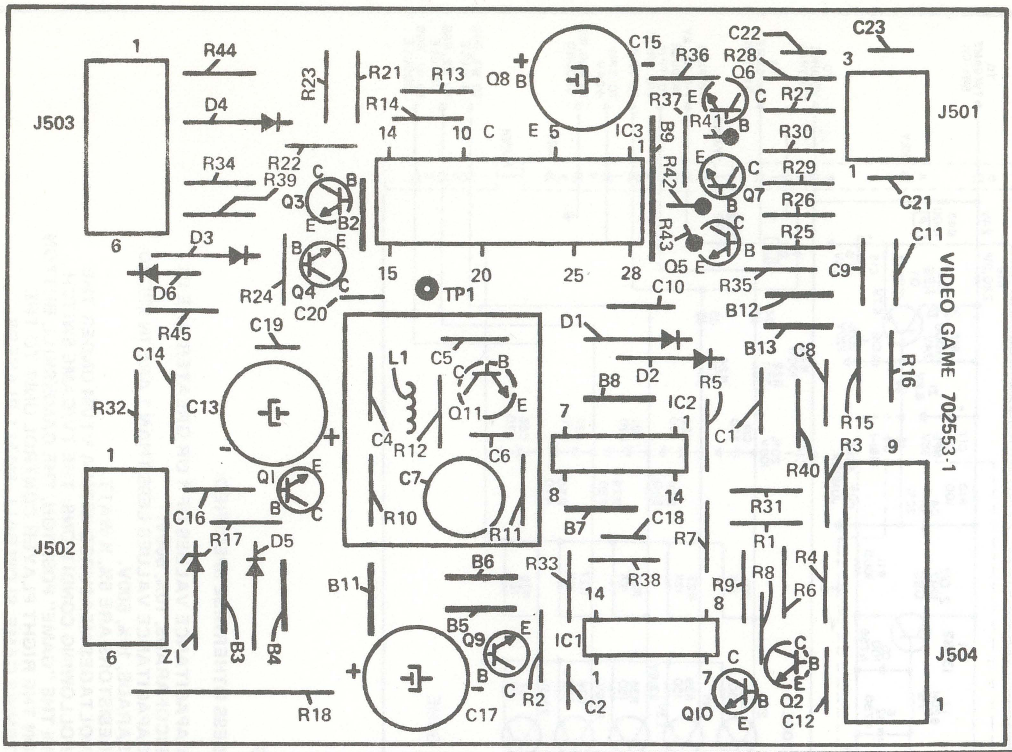
**Under no circumstances may the original design be modified or altered without permission from The Magnavox Company, otherwise the consumer may be exposed to fire and/or shock hazards.**

NOTES:

UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE VALUES OF 1 OR GREATER ARE IN PICOFARADS, 10%, 500V.
2. CAPACITANCE VALUES LESS THAN 1 ARE IN MICRO-FARADS, 10%, 500V.
3. RESISTORS ARE 5%, ¼ WATT.
4. VOLTAGES MEASURED WITH A VTVM UNDER THE FOLLOWING CONDITIONS: THE TV/GAME SWITCH IN THE "GAME" POSITION, THE GAME/SKILL BUTTON ON THE RIGHT PLAYER CONTROL UNIT TO THE TENNIS GAME, SLOW BALL, SMALL PLAYERS POSITION.
5. EP=EARLY PRODUCTION LP=LATE PRODUCTION

Fig. 3-64. Odyssey game module 702553-1 used in the BG4305 receiver.




| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| | COILS | |
| L1 | Peaking Coil, 82 uh | 361475-820 |
| | CAPACITORS<br>Values, tolerances and voltage ratings for capacitors not listed are shown on the schematic or are 10%, 500V. | |
| C5 | Ceramic, 100 pf.,5%,500V (NPO) | 250546-1015 |
| C6 | Ceramic, 82 pf.,5%,500V (N750) | 250549-8205 |
| C7 | Trimmer, 6-38 pf. | 260220-2 |
| C15 | Electrolytic, 100 mfd., 35V | 270109-1235 |
| C17 | Electrolytic, 100 mfd., 35V | 270109-1235 |
| | RESISTORS<br>Values, tolerances and wattage ratings for resistors not listed are shown on the schematic or are 5%, ¼ Watt. | |
| R18 | 220, 10%, 2W (Metal Film) | 230192-2219 |
| | SEMICONDUCTORS | |
| D1 | Silicon Diode | 530181-1001 |
| D2 | Silicon Diode | 530181-1001 |

| REF. | DESCRIPTION | PART NO. |
|---|---|---|
| D3 | Silicon Diode | 530181-1001 |
| D4 | Silicon Diode | 530181-1001 |
| D5 | Silicon Diode | 530181-1001 |
| Q1 | NPN Silicon | 610232-1 |
| Q2 | NPN Silicon | 610232-1 |
| Q3 | NPN Silicon | 610232-1 |
| Q4 | NPN Silicon | 610232-1 |
| Q5 | NPN Silicon | 610232-1 |
| Q6 | NPN Silicon | 610232-1 |
| Q7 | NPN Silicon | 610232-1 |
| Q8 | NPN Silicon | 610232-1 |
| Q9 | NPN Silicon | 610232-1 |
| Q10 | NPN Silicon | 610232-1 |
| Q11 | NPN Silicon | 610139-2 |
| Z1 | Zener Diode (6.8V) | 530157-689 |
| IC1 | Binary Counter IC | 612124-1 |
| IC2 | Quad Two Input Nand Gate IC | 612125-1 |
| IC3 | Odyssey IC | 612114-1 |
| | MISCELLANEOUS | |
| | 2 Pin Connector (2 used) | 181023-2 |
| | 3 Pin Connector (4 used) | 181023-3 |
| | 5 Pin Connector | 181023-5 |
| | Shield, Top | 733105-1 |

**Fig. 3-65. PC board diagram (top) and parts list (bottom) of the 702553-1 game module used in Model BG4305 (T991 chassis).**

spective sockets. Press the reset button on the left player control unit after switching from TV to game, or after turning the set on while in the game mode. Various symptoms, such as a moving yellow horizontal line and a squeal from the speaker, disappear after pressing the reset button.

A defective player control unit could cause a loss of player control, an inability to change games or skill levels, or the inability to reset the game to zero. Any of these problems could also be intermittent. Since the player controls and their associated switches are plug-in extensions, they should be checked or substituted to ensure against any broken or intermittent connections. The TV/game switch is another related component that could affect the set whether in the TV or game mode. The switch and wiring to the switch should be checked for broken or intermittent connections.

Conventional troubleshooting techniques combined with an extra set of player control units, an extra game module, and a 703665-4 RGB module should result in fast repair of any defective BG4305.

# CHAPTER 4

# STUDIO II BY RCA MODEL 18V100

Studio I s a sophisticated, microprocessor-based system for home entertainment using a broadcast TV receiver as the display device.

The heart of the Studio II is a solid-state, 40-pin integrated circuit microprocessor that functions as a miniature computer. It provides central computer control for a great variety of educational and entertainment programs. Program memory for five built-in games—doodles, patterns, bowling, freeway, and addition—is included in the console. A receptacle in the console accepts plug-in program cartridges for many additional games such as tennis, baseball, and blackjack.

## SYSTEM DESCRIPTION

Studio II consists of three major pieces:

*Control Console*—Houses the keyboards and all electronics for program selection and processing. (Refer to Fig. 4-1.) All electronics in the console (digital, RF oscillator/modulator, and audio circuits) are on a single PC board. Signal information from the console is transferred to the selector switch unit through a single coaxial cable. This same cable carries DC power from the selector switch unit to the console to operate the electronics.

*Selector Switch Unit*—Forms the interface between the control console, the Studio II power supply unit, the TV receiving antenna, and the TV receiver. A two-position switch allows the TV receiver to be connected conveniently to either the Studio II or to the receiver's antenna system. This switch also serves as the game's on/off switch.

*Power Supply Unit*—A sealed, 120V AC to 9V DC adapter with a 6-foot (1.8m) cord and plug that connects to a miniature (3 mm) phone jack on the switch selector unit. The 9V DC is coupled to the game's 18-foot (5.5m) coaxial cable through an RF-filtering circuit housed in the selector switch unit.

The recommended Studio II service procedure is to determine whether the problem is in one of the periphery components, the interconnecting cables, or the console itself. If the PC board in the console is found to be faulty, it must be returned to RCA for repair on an exchange basis.

**IMPORTANT**

No attempt should be made to adjust or repair an inoperative PC board, with the exception of the clock frequency adjustment.

As an aid to servicing Studio II, a test cartridge (see below) is available from RCA. The cartridge is not essential to service Studio II; however, it does provide a quick and convenient means for isolating malfunctions in the digital systems.

When a Studio II comes in for service, it is important that you have *all three* assemblies: selector switch unit, power supply unit, and console. If the complaint involves one or more plug-in cartridges, these should be included as well.

## SYSTEM CHECKING

Checking Studio II operation can be done quickly and easily using a test cartridge available from RCA. System performance can also be checked by operating each built-in game function; however, this procedure takes more time than the test cartridge check.

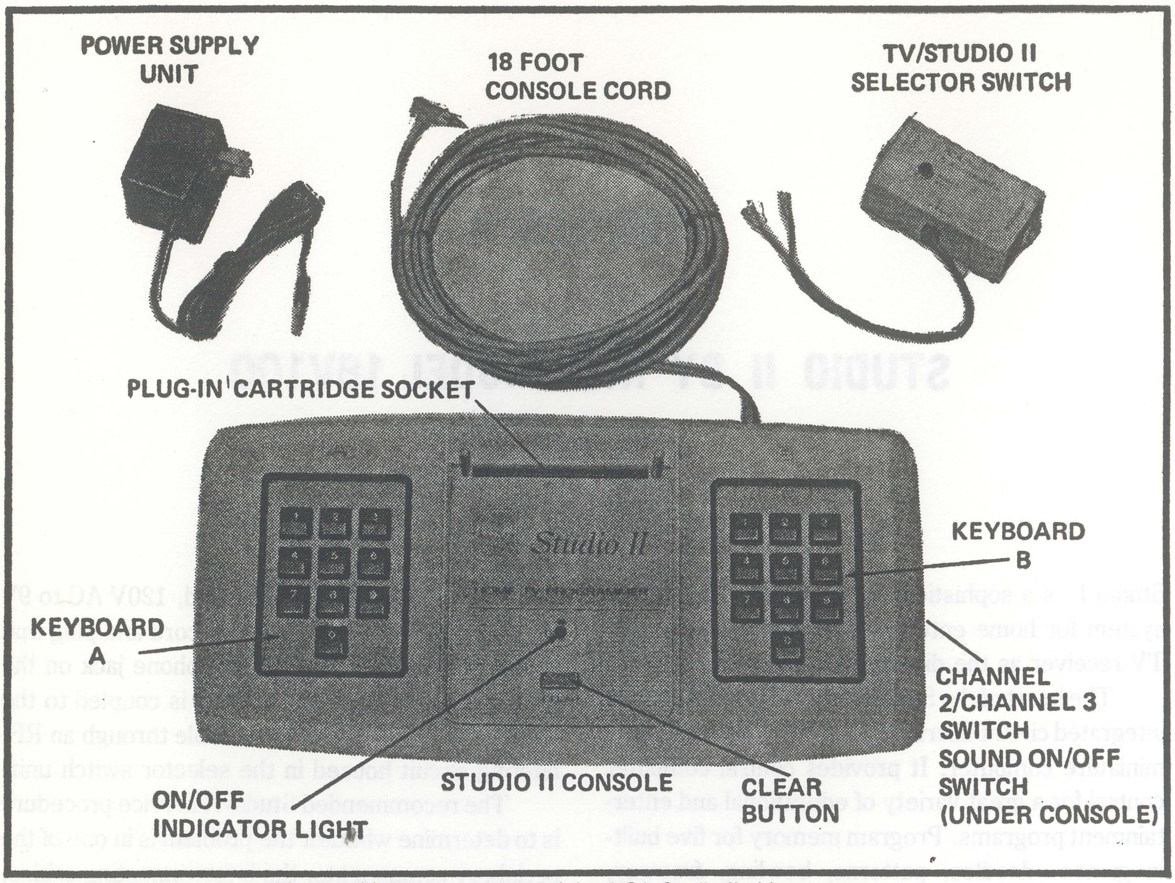



Fig. 4-1. Major components of the RCA Studio II video game.

## SYSTEM CONNECTIONS

Studio II connects to the 300Ω VHF antenna terminals of any TV receiver. Figure 4-2 describes the hookup of the three subassemblies. Figures 4-3,

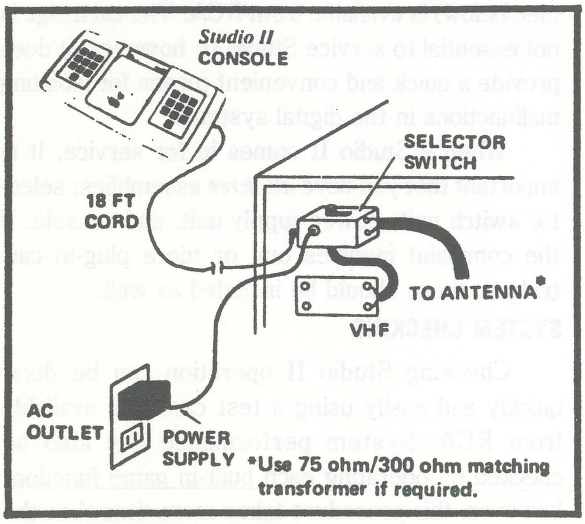



Fig. 4-2. Hookup diagram for the Studio II.

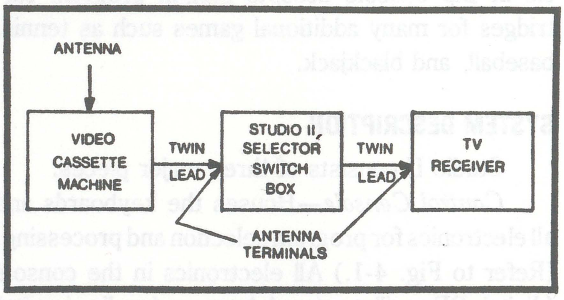



Fig. 4-3. Hookup method for attaching the Studio II to a home videotape recorder and TV receiver setup. Notice the antenna switch box is located between the videotape recorder and the TV receiver.

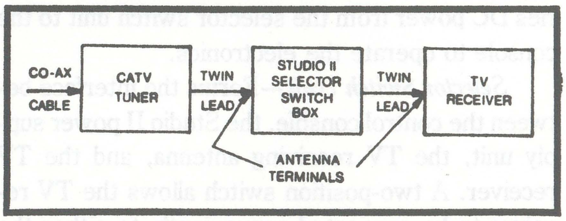



Fig. 4-4. Hookup method for connecting the Studio II in a CATV tuner and TV receiver setup. The antenna switch box goes between the CATV tuner and the home TV receiver.

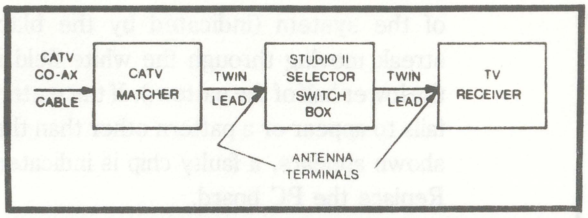



Fig. 4-5. Hookup method for connecting the Studio II to a CATV cable matcher and TV receiver setup. Connect the antenna switch box between the cable matcher and the TV receiver.

4-4, and 4-5 describe the hookups with typical videotape machines and typical cable TV setups.

Recessed on the underside of the console are two slide switches (Fig. 4-6). One switches the game sound (beeper) on or off while the other changes the operating channel. Studio II operates on TV channel 2 or TV channel 3, depending on the position of the switch. The switch should be set on the unoccupied channel or in areas where both channels are occupied, on the channel with the weakest broadcast signal. Units are shipped from the factory with the switch in channel 3 position.

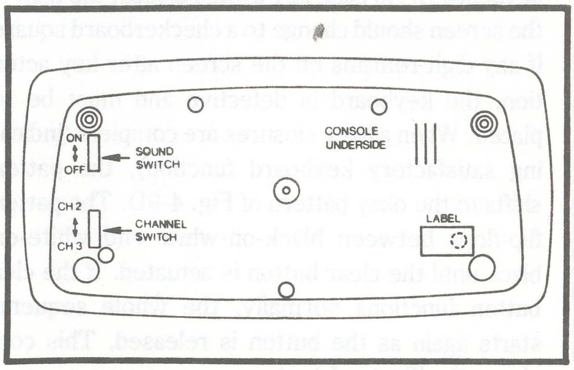



Fig. 4-6. Bottom side of the console assembly of the Studio II. Note the location of the channel select switch and the sound on/off switch.

Slide the switch on the selector switch unit (Fig. 4-7) to Studio II. This sends power to the console (indicated by the red glow of the pilot light on the console) and connects it to the TV receiver. Studio II is now ready for operation.

## TEST PROCEDURES

Press the clear button on the console and press key 4 on left-hand keyboard A (key A4). This sets Studio II for freeway. The track (Fig. 4-8) appears immediately. If necessary, adjust the receiver's fine tuning and vertical/horizontal hold controls.

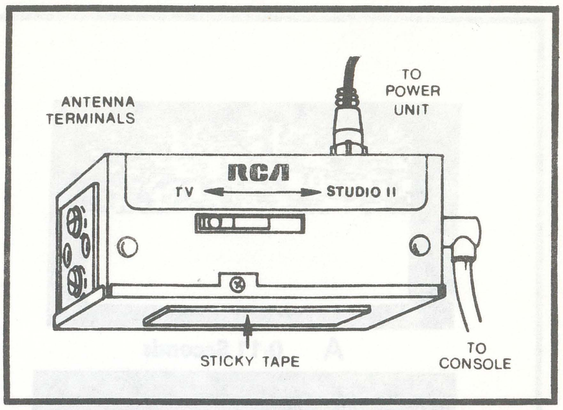



Fig. 4-7. Side view of the selector switch box for the Studio II. Use the sticky tape on the bottom of the box to attach it to a surface close to where it will be used.

### Operational Checks With Test Cartridge

The test cartridge, which plugs into the cartridge slot on the Studio II console, scans the digital circuitry for trouble with a routine that takes about 30 seconds. If it finds a malfunction, the fact is indicated on the TV screen; if there is no trouble, the cartridge sets up a test for the two keyboards.

NOTE

The test cartridge requires substitution of the power unit during test. Use the special 500 mA power unit (see parts list) instead of the original power unit.

1. Press and hold the clear button on the Studio II console. Insert Tester I cartridge into slot while holding the clear button.

NOTE

Insert cartridge into console with label side toward clear button. Follow label directions concerning removal of conductive rubber strip covering the plug.

2. Release the clear button. A pattern similar to that of Fig. 4-9A appears on screen immediately, and Tester I begins its scan

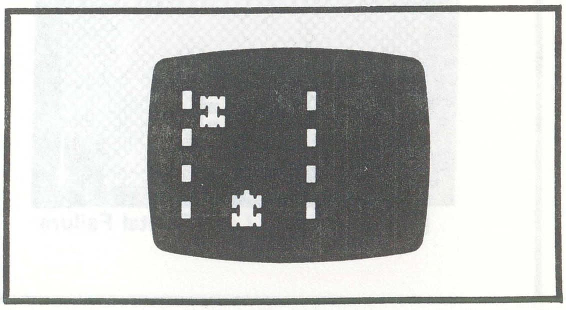


Fig. 4-8. Freeway display. Pressing the clear button on the console and key 4 on keyboard A displays the freeway track immediately.

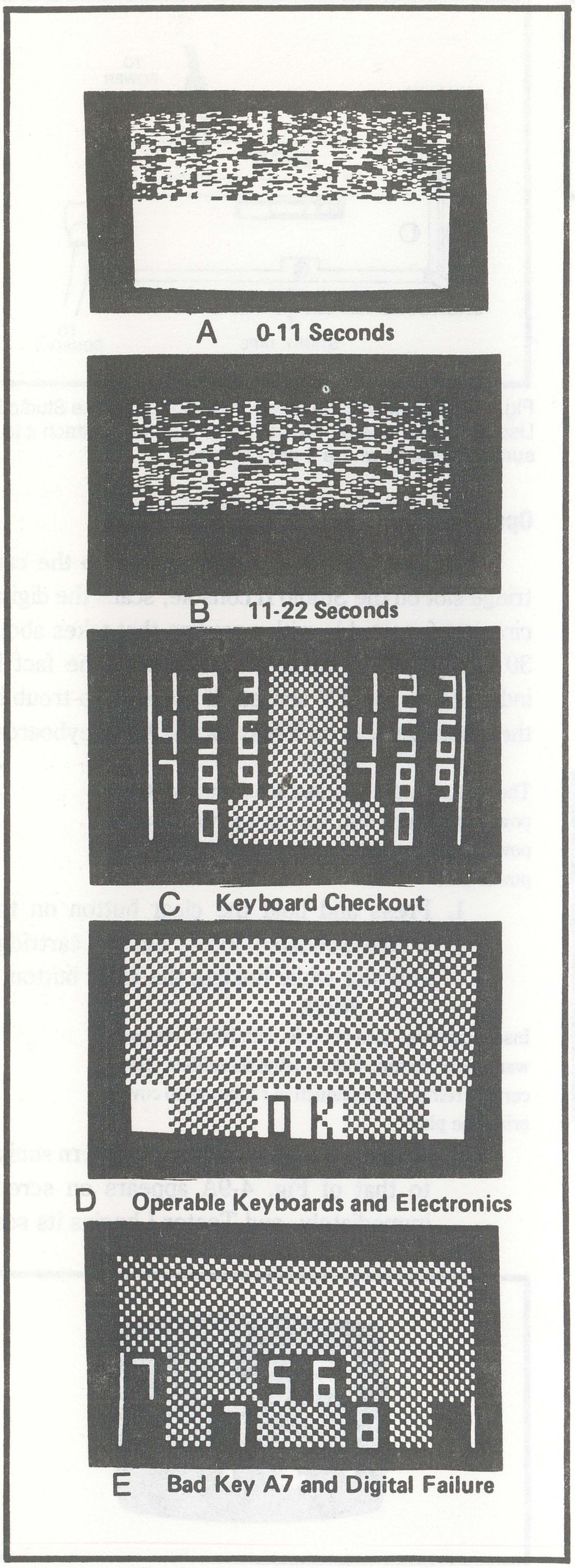



Fig. 4-9. Tester I screen patterns. These patterns appear during the time intervals shown or conditions indicated. Refer to step 2 under Operational Checks With Test Cartridge.

of the system (indicated by the black streak moving through the white field in the lower half of the pattern). If the pattern fails to appear or a pattern other than that shown appears, a faulty chip is indicated. Replace the PC board.

In about 11 seconds, the first scan is complete. The display shifts to the pattern shown in Fig. 4-9B with a white streak scanning a black field. This scan takes another 11 seconds. At the end of the second scan, the system changes the pattern on the lower half to a series of transient vertical white lines on black, then a series of black lines on white. This sequence takes about 2 seconds. At the end of this short sequence, the pattern again shifts to that illustrated in Fig. 4-9C. This indicates all memories operational. A digit or digits appearing in the checkerboard pattern in the center of the screen, as shown in Fig. 4-9E, indicates chip failure in the PC board and the board must be replaced.

If the checkerboard appears as in Fig. 4-9C, touch the keys—one at a time—of keyboard A, then keyboard B. As each key switch closes, the digit on the screen should change to a checkerboard square. If any digit remains on the screen after key actuation, the keyboard is defective and must be replaced. When all key closures are complete (indicating satisfactory keyboard function), the pattern shifts to the okay pattern of Fig. 4-9D. The pattern flip-flops between black-on-white and white-on-black until the clear button is actuated. If the clear button functions normally, the whole sequence starts again as the button is released. This completes the Tester I test.

NOTE

Reconnect the original power unit into the system. Store the special unit with the test cartridge for future use.

### Operational Checks Using Built-In Programs

The following instructions are for operating the built-in resident games to evaluate Studio II performance:

*Bowling Game*—Press the clear key. Press key A3 (left-hand keyboard). Screen will display scorecard (Fig. 4-10) for about 3 seconds and immediately sets up alley (Fig. 4-11) with bowling ball moving up and down at the left side.

Keyboard A is in action: Pressing key A5 releases a straight ball toward the pins; key A2 sends

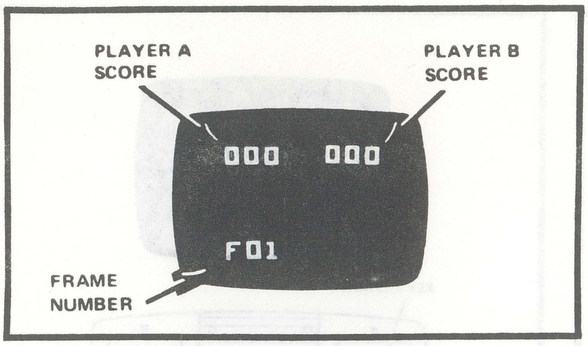



Fig. 4-10. Scorecard display. Pressing the clear button on the console and key A3 displays this image for about 3 seconds. Then the display in Fig. 4-11 is set up.

a ball with a left (upward) hook while key A8 delivers a right (downward) hook (Fig. 4-11). Knocking out all pins on one throw registers a strike with a score of 20 (ST-20 at lower-left corner of alley); two throws, a score of 15 (SP-15 on screen). The scorecard reappears for about 3 seconds after the second ball is thrown or all pins are downed. Player 2 then plays right-hand keyboard B.

*Freeway Game*—Press the clear key. Press key A4; racetrack appears on screen (Fig. 4-12). Press key B0 to start race. Press and hold key B4 to steer car to left; key B6 steers car to right. Press A2 to speed up race (throttle); key A8 slows car (brake). Object is to accumulate mileage by avoiding collisions with computer-controlled (narrow-bodied) car in a 2-minute race. At the end of the race, the screen displays the distance traveled.

*Addition Function*—Press the clear key. Press key A5. Screen display appears as shown in Fig. 4-13. Player has 5 seconds to add the three digits in the lower group and press the correct answer on keyboard A or B. For example, the *130* on Fig. 4-13 adds up to *4*. Punch A3 or B3 to score. The sooner the correct total is entered, the higher the score.

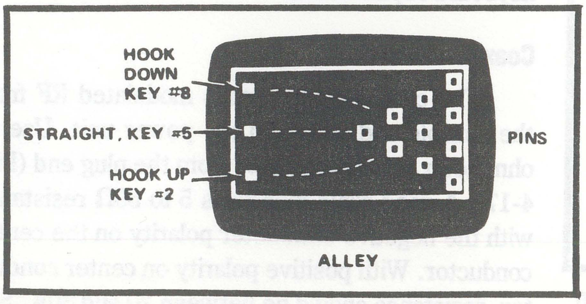



Fig. 4-11. Bowling alley display. Pressing the indicated keys on keyboard A releases the ball in the fashion shown.

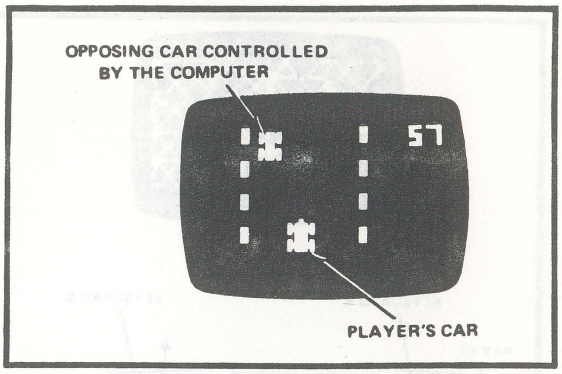



Fig. 4-12. Racetrack display. After pressing the clear button and key A4, this image appears.

(Maximum score for each entry is 11). If the wrong total is entered, the keyboard *locks out* and the player gets no second chance on the on-screen combination. There are 20 sets in the run in random order.

*Patterns Function*—Press the clear key. Press key A2. Screen remains dark. Press key B4, then key B0. The computer than paints the screen white from right to left and from bottom to top. Once the matrix is all white, the computer then paints the screen black. Press key B5, the painting stops or freezes; press key B0, painting resumes.

The keys of keyboard B write on the screen according to the white arrowheads on the keyboard (Fig. 4-14). To form an interesting pattern, press the clear key, then A2, B2 fifteen times, B6 once, and then B0. The memory stores up to 130 key entries or moves. After 130 moves, the computer automatically starts to repeat the pattern. For 129 or fewer moves, key B0 must be pressed to start the repeat cycle.

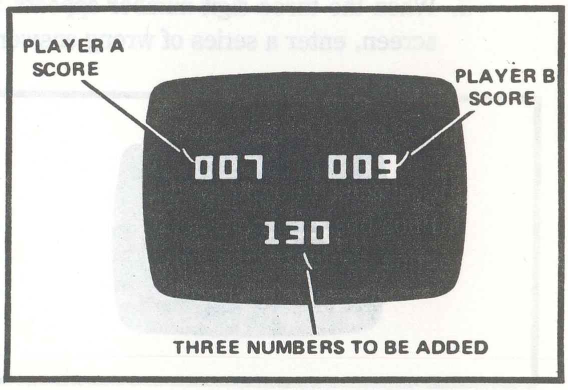



Fig. 4-13. Addition display. Pressing the clear button and key A5 displays this image. The player has 5 seconds to enter the correct answer on the keyboard.

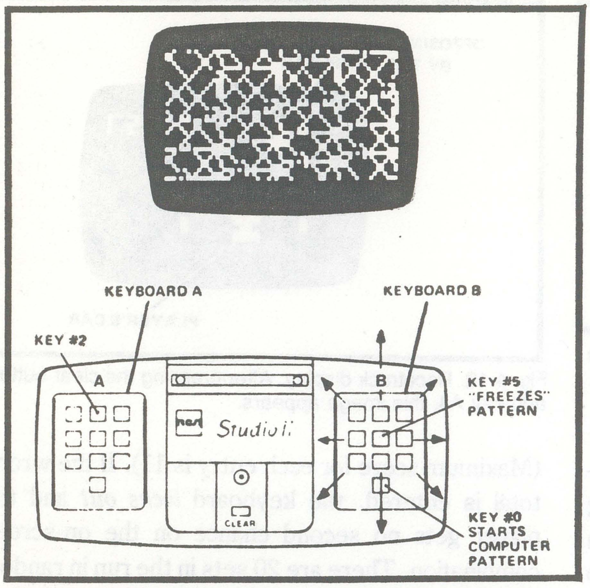



Fig. 4-14. Pattern display. The key of keyboard B writes on the screen in the direction indicated by the arrows.

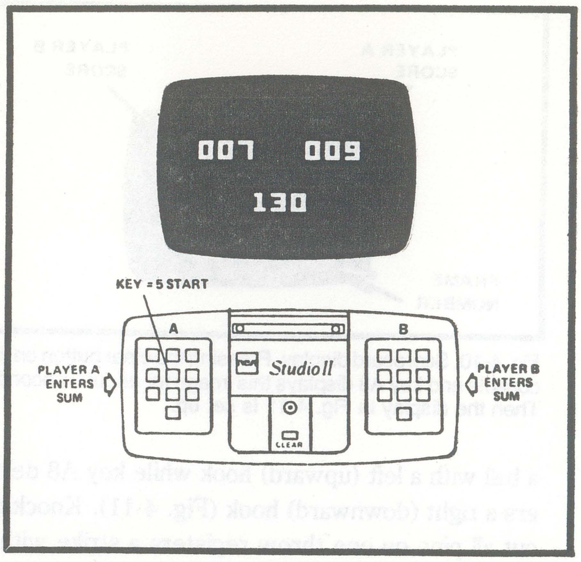



Fig. 4-16. Test made using the keyboard and built-in addition game. By entering the wrong answer, the beeper sounds, indicating that key operational.

*Doodles Function*—Press the clear key. Press A1. A single dot appears on the screen at the lower-left corner. Use the keys on keyboard B to move the spot according to the white arrows on panel (Fig. 4-15). Key B5 leaves a trail as player writes with keyboard B. Pressing key B0 leaves no trail. Retrace steps to erase lines already written.

## Keyboard Tests

If the Tester I cartridge is available, use it to isolate keyboard malfunction. If Tester I is unavailable, the keyboards can be tested using the built-in addition game:

1. Punch up addition game (key A5). Sound switch must be in the on position.
2. When the three-digit number appears on screen, enter a series of wrong answers, beginning with A1. (See Fig. 4-16.) As each button is pressed, the beeper sounds, indicating the particular button is operational. The beeper sounds only during the 5 seconds that the random-order display is on screen. Usually, the entire keyboard can be checked during the 5-second display. If any key fails to sound, that key is faulty and the entire keyboard should be replaced.

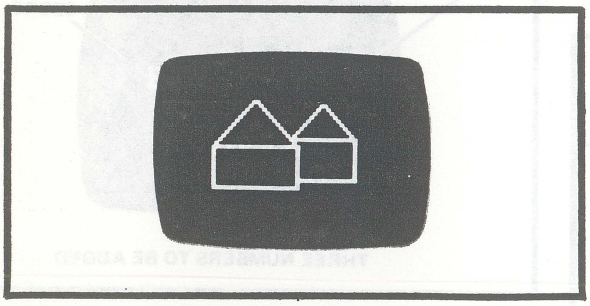


Fig. 4-15. Typical doodle display. Pressing the clear button and key A1 displays a single dot at the lower-left corner of the TV screen.

## Double-Hit Keyboard Complaints

Some early production units (serial numbers 37125 and lower) occasionally exhibit a keyboard malfunction termed double-hit when Studio II operates in the patterns mode (unwanted dots appear on the screen, and the beeper sounds twice for only one key entry). The only remedy for double hits is keyboard replacement.

## Coaxial Cable Tests

The coaxial cable carries modulated RF from the console and DC from the power unit. Use an ohmmeter to test the cable from the plug end (Fig. 4-17). A good cable measures 5 to 50Ω resistance with the negative ohmmeter polarity on the center conductor. With positive polarity on center conductor, resistance should be between 20 and 30K. See *Coaxial Cable Replacement*.

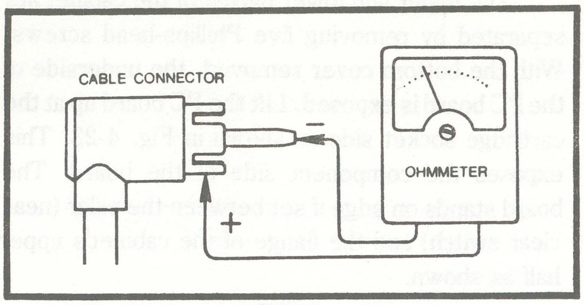



Fig. 4-17. Ohmmeter test of RF coax cable.

## Selector Switch Unit Tests

The quickest test for a troublesome selector switch unit is substitution with a new unit (see parts list). If a new unit is unavailable, use a DC voltmeter and ohmmeter to check the unit circuitry (see schematic of Fig. 4-18) for open or short-circuited components.

When the switch is in the Studio II position, it connects the coaxial cable from the console to the twin lead and completes the DC circuit between the console and power supply. With the switch in the TV position, it disconnects the console and forms a circuit between the antenna terminals and the twin lead for normal TV reception.

If the selector switch unit is defective, it must be replaced (see parts list) since it cannot be satisfactorily repaired in the field. It is carefully manufactured so as not to exceed the RF radiation limits specified by the FCC.

If snowy pictures occur in the TV position or the Studio II cannot be shut off, check antenna connections for short circuits to the metal box or rivets holding terminal board. If either antenna lead touches the box or rivets, snowy pictures may result. Late production units use insulated rivets which eliminate such problems.

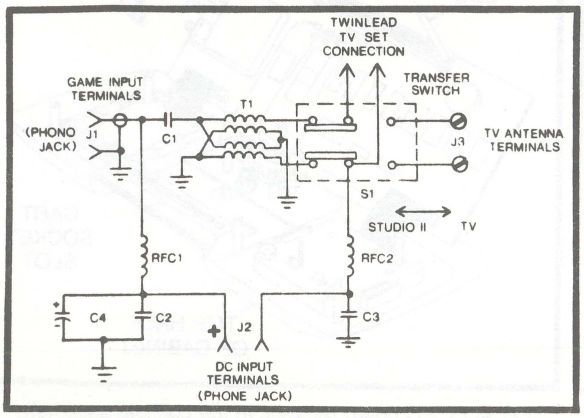



Fig. 4-18. Schematic diagram of the selector switch box.

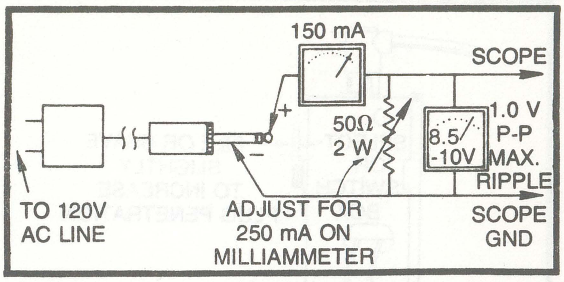



Fig. 4-19. Method recommended for checking the output voltage and ripple content of the power supply unit.

## Power Supply Unit

The power supply unit operates between carefully chosen voltage and ripple limits. To check unit for satisfactory operation, connect unit as shown in Fig. 4-19. DC output under these conditions ranges between 8.5 and 10V. Ripple on this DC (measured with oscilloscope) must not exceed 1V P-P. Replace the power supply unit if beyond these specifications (see parts list).

## Leakage Current Test

With the power supply unit plugged into an AC outlet, check for leakage current to earth ground on both poles of the phone plug, as shown in Fig. 4-20, using an AC milliammeter. Leakage current *must not* exceed 0.5 mA. Reverse the AC plug polarity and recheck the leakage current.

If the power unit checks out okay but is inoperative with operable Studio II console, check the fit of the DC plug and jack. Some early production plugs and jacks have tolerances that conflict and prevent adequate plug penetration. The solution to this problem is often simply to increase the effective

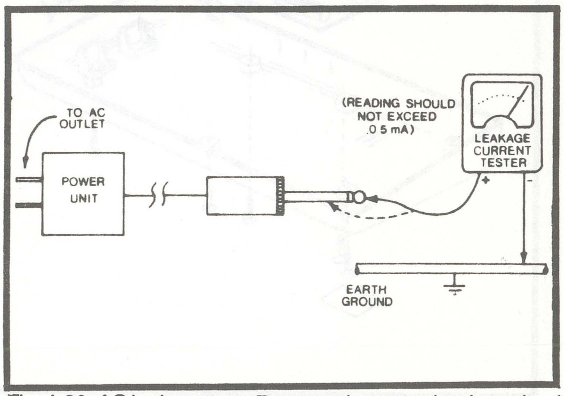



Fig. 4-20. AC leakage test. Reverse the meter leads to check the leakage in the opposite direction.

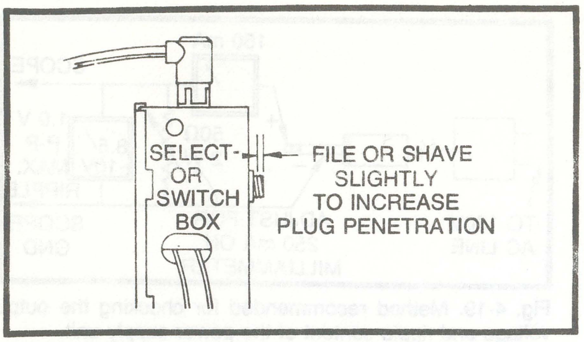



Fig. 4-21. Early production units sometimes require modification of the power plug to ensure proper fit.

length of the plug by filing the jack slightly as shown in Fig. 4-21. (Use a sharp knife to remove any untrimmed mold flash from plug if present.)

## CONSOLE DISASSEMBLY

The console consists of six separate subassemblies: the two halves of the cabinet, PC board, two keyboards, and a clear switch/power-on indicator.

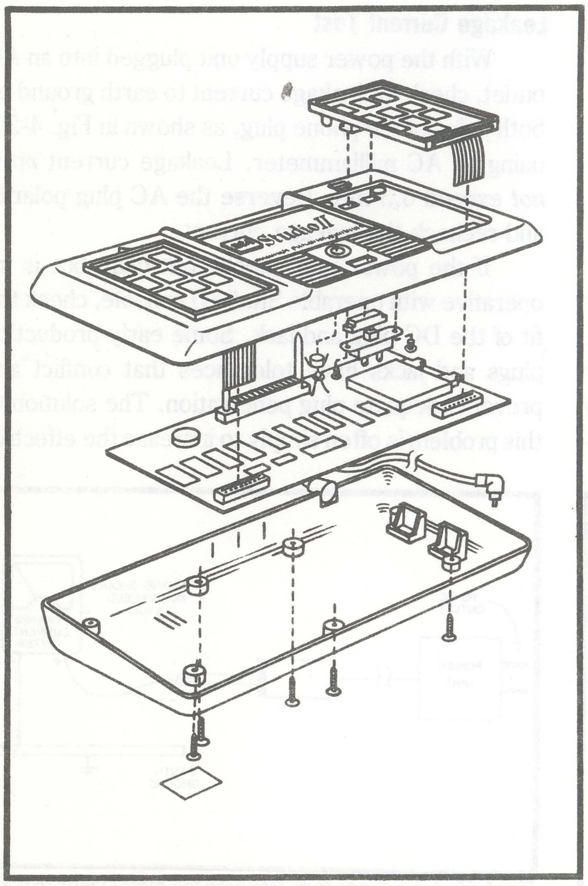


Fig. 4-22. Exploded view of the Studio II console.

The upper and lower halves of the cabinet are separated by removing five Phillips-head screws. With the bottom cover removed, the underside of the PC board is exposed. Lift the PC board up at the cartridge socket side as shown in Fig. 4-23. This exposes the component side of the board. The board stands on edge if set between the pillar (near clear switch) and the flange of the cabinet's upper half as shown.

NOTE

The channel-change and sound on/off switches, plug-in cartridge connector, and other components mounted on the PC board are not field replaceable. All PC board faults (except speaker) require board exchange.

CAUTION

Tuner sprays containing silicon must not be used on slide switches. Irreparable switch damage will result.

## COMPONENT REPLACEMENT PROCEDURES

The following four procedures indicate how to remove and replace key components of the Studio II. All of these procedures involve replacing major items and not discrete components, such as resistors, switches, etc. Extreme care should be exercised so that defective assemblies can qualify under the exchange plan for these items.

### PC Board Removal

Disconnect black, white, and yellow wires from board; unsolder coaxial cable from board and carefully pull out keyboard ribbon leads from PC board connectors. See *PC Board Packing and Shipment* for board exchange details.

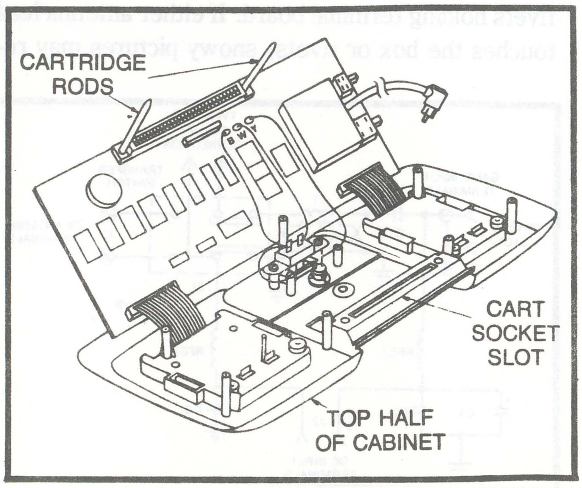



Fig. 4-23. PC board removal in the console assembly.

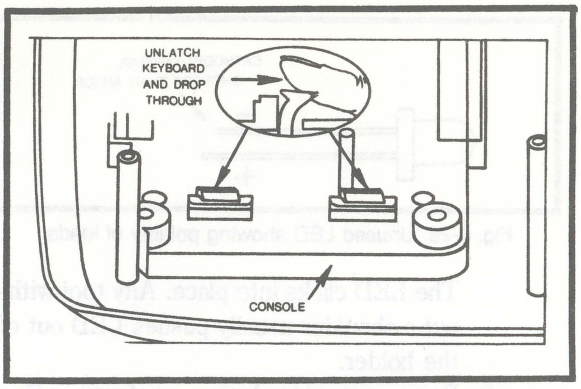



Fig. 4-24. Releasing the keyboard from the console unit.

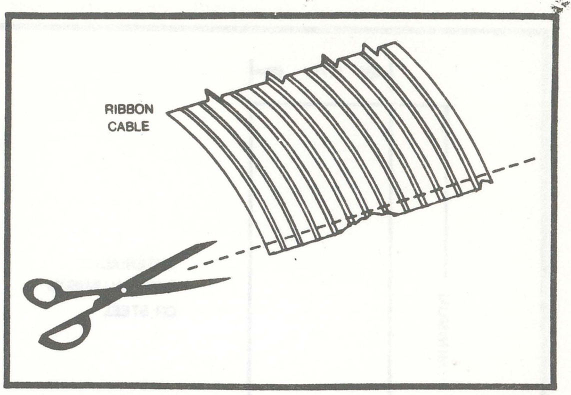



Fig. 4-25. Method used to trim back the ribbon cable to make good contact in the connector.

## Keyboard Replacement

1. Keyboard replacement requires console disassembly as described above.
2. Unplug the ribbon cable of the defective keyboard from the ribbon connector on the PC board by pulling the ribbon straight out of the connector.
3. Release the keyboard from the console by unlatching two brown colored latches as illustrated in Fig. 4-24. Keyboard is now free of console.
4. Install new keyboard by feeding ribbon cable through opening in console before latching keyboard in place.
5. Push ribbon cable into connector.

NOTE

Some Studio II units use unenclosed ribbon connectors on PC board. Ribbon cable must center in the connector so that all 11 leads contact for proper operation.

6. If ribbon cable from keyboard fails to make good contact in connector, trim back 0.0625 inches (1.58 mm) from edge with ordinary household scissors to expose fresh contact. See Fig. 4-25.

## Coaxial Cable Replacement

1. Remove bottom half of console cabinet. Pry off metal shield covering end of coaxial cable. Pry carefully so as not to damage foil wiring on PC board.
2. Disconnect cable by unsoldering the shield first. Do not overheat foil.
3. Install replacement cable as shown in Fig. 4-26 by soldering center lead first.
4. Install shield cover carefully and firmly. Center coaxial cable in slot in cover (Fig. 4-26). Shield must be fully seated to minimize radiation of modulated carrier.

## LED Indicator Replacement

Installing a new LED in the console requires the use of a special tool that can be fabricated from a piece of sheet metal with a sabre saw. See Fig. 4-27 for dimensions.

1. Unsolder the black and white lead wires from the clear switch terminals. Unsolder the yellow wire from the LED pigtail. This frees the console top half for LED replacement.
2. Snip both LED pigtails off close to the LED.
3. Place console cover, face up, on block and drive out the old LED with a small screwdriver or 1/8-inch (3.175 mm) drift pin.

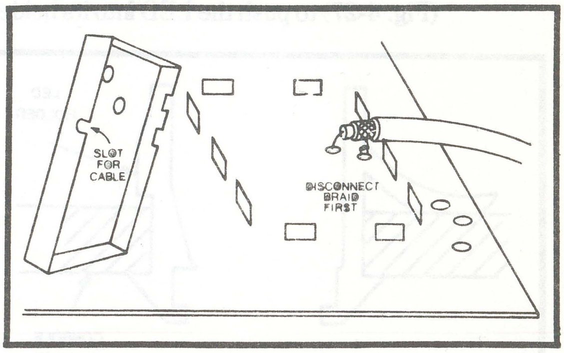



Fig. 4-26. Coaxial cable replacement procedure. Disconnect the shield first to release the cable. Solder the center conductor first upon installation. Do not overheat the PC foil or cable.

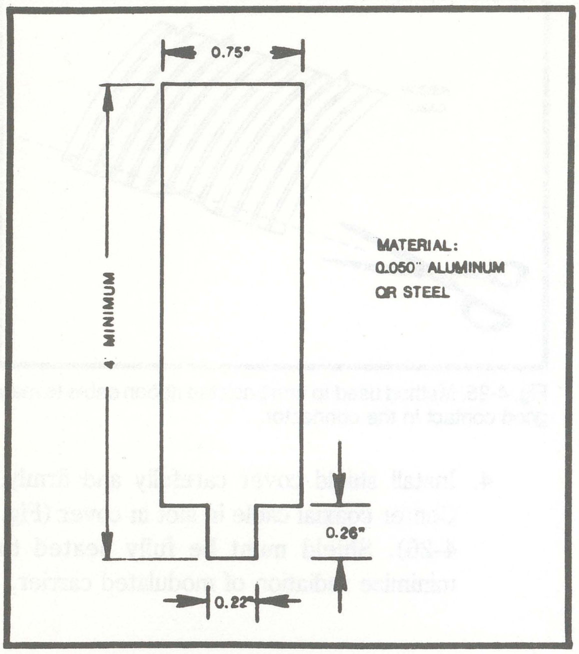



Fig. 4-27. Construction of LED replacement tool. This tool is needed to push the LED into its holder.

4. From the underside of the cover, bend the clipped pigtails back and collapse the black plastic holder with needlenose pliers or diagonal cutters. Remove the holder from the console holes using pliers or cutter.
5. Install the new LED holder. Press the holder gently into the hole in the console cover until it clicks into place (Fig. 4-28).
6. Place the new LED in the LED holder with the shorter (cathode) pigtail toward the side connected to the clear switch (see Figs. 4-29 and 4-30). This is important; indicator cannot light if connected with reversed polarity. Use the fabricated tool (Fig. 4-27) to push the LED into its holder.

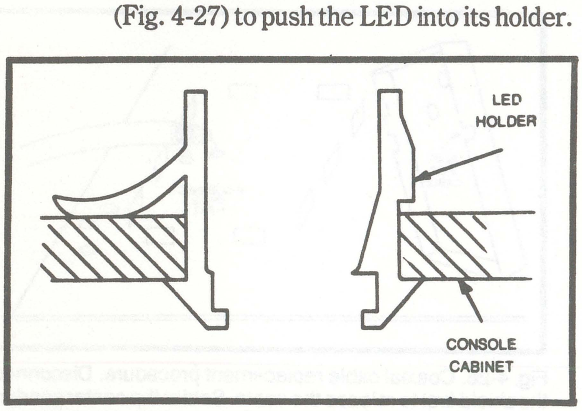



Fig. 4-28. Cross-sectional view of seated LED holder in the console cabinet.

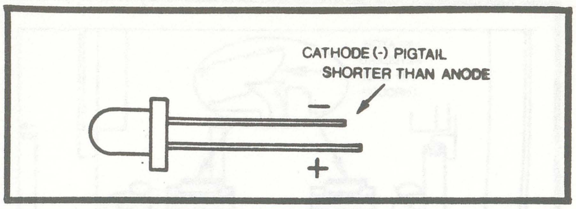



Fig. 4-29. Unused LED showing polarity of leads.

The LED clicks into place. Any tool without a shoulder usually pushes LED out of the holder.

7. Form snipped lead wires as shown in Fig. 4-30 and connect new LED pigtails to them. Solder quickly to prevent overheating the LED.

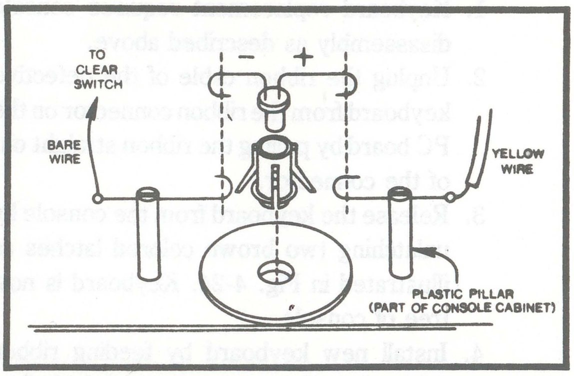



Fig. 4-30. Proper formation of LED leads before soldering it into place.

8. Connect black, white, and yellow leads from PC board to complete installation (see Fig. 4-31).

## CLOCK FREQUENCY ADJUSTMENT PROCEDURE

Incorrect clock frequency adjustment causes pattern weave on screen. This results from a beat

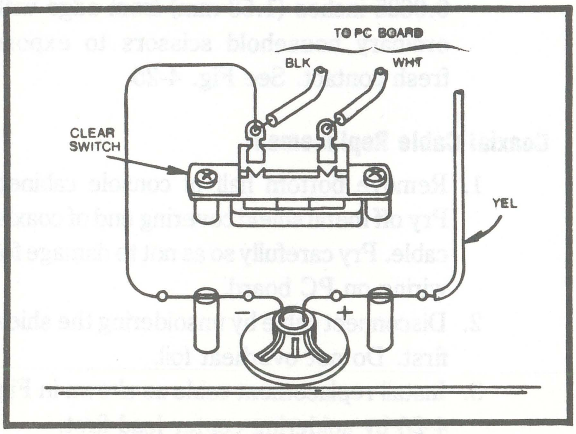



Fig. 4-31. Proper installation of the LED and its leads.

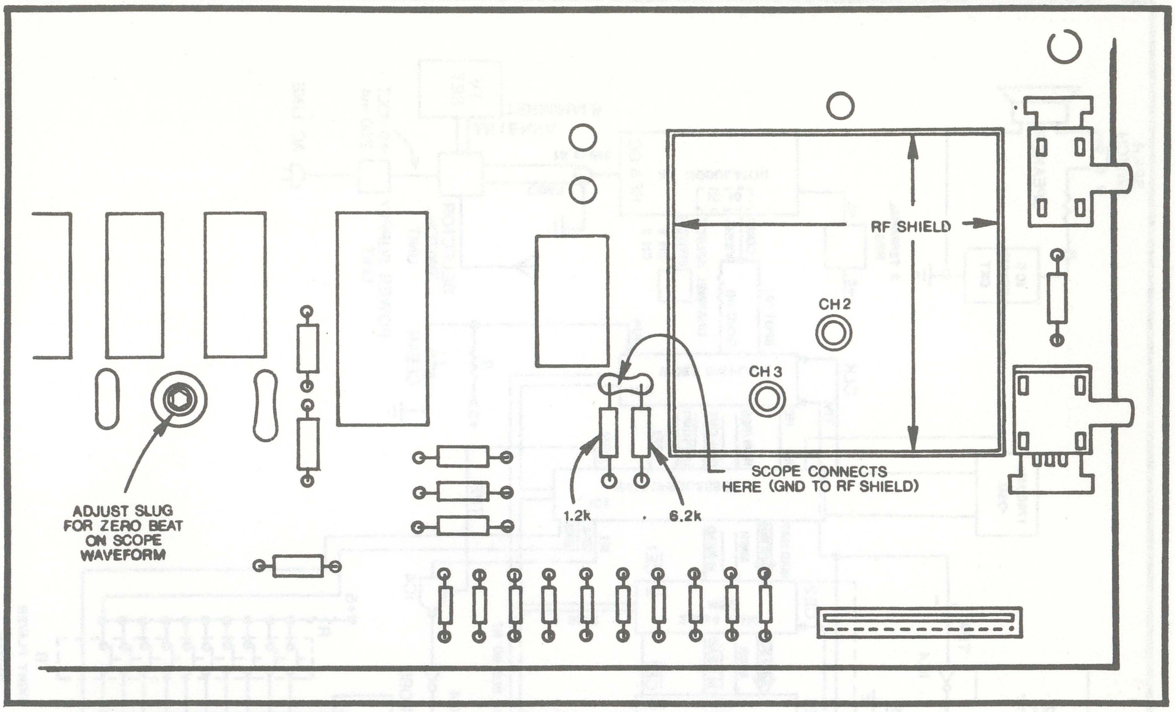



Fig. 4-32. Clock frequency adjustment. Connect the scope probe to the junction of the two resistors shown. Attach the scope ground lead to a suitable ground.

note between the vertical sync rate of Studio II and the hum frequency in the TV receiver. If the beat note is more than 0.5 Hz, the weave becomes noticeable to the critical user. Clock frequency is a slug adjustment on the PC board.

1. Connect a scope probe to the junction of two resistors as shown in Fig. 4-32. Connect the scope ground to RF shield, cartridge post, or to other suitable board ground.
2. Adjust the scope time base for a total sweep length of 20 ms or more (sync on line) and vertical input sensitivity for about 250 mV/cm (0.625 V/in.).
3. Push the clear button on the console and adjust the slug slowly for zero waveform drift. See Fig. 4-33. Guard against overadjustment. A schematic diagram of the Studio II is shown in Fig. 4-34.

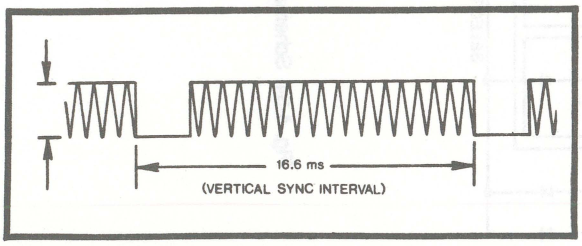



Fig. 4-33. Proper waveform of clock. Adjust the slug shown in Fig. 4-32 slowly for zero drift.

## EXCHANGE PLAN DESCRIPTION

RCA operates a PC board refurbishing facility at Swannanoa, North Carolina. Defective PC boards sent to this facility are refurbished and returned to the sender at a cost of $15.00 (price subject to change without notice, provided, of course, the exchange board is repairable.

## PC BOARD PACKING AND SHIPMENT

If the custom shipping container described below is not available, pack the PC board in a cushion of crumpled newspapers or bubble pack in a suitably sized carton. Make sure the board is completely surrounded with cushion to prevent shipping damage that might make the board useless for exchange. Be sure to include a completed questionnaire (Fig. 4-35) in the package.

1. Pack defective PC board in foam shipping container as shown in Fig. 4-36. Note relative positions of PC board components and the molded-in supports in the foam plastic.

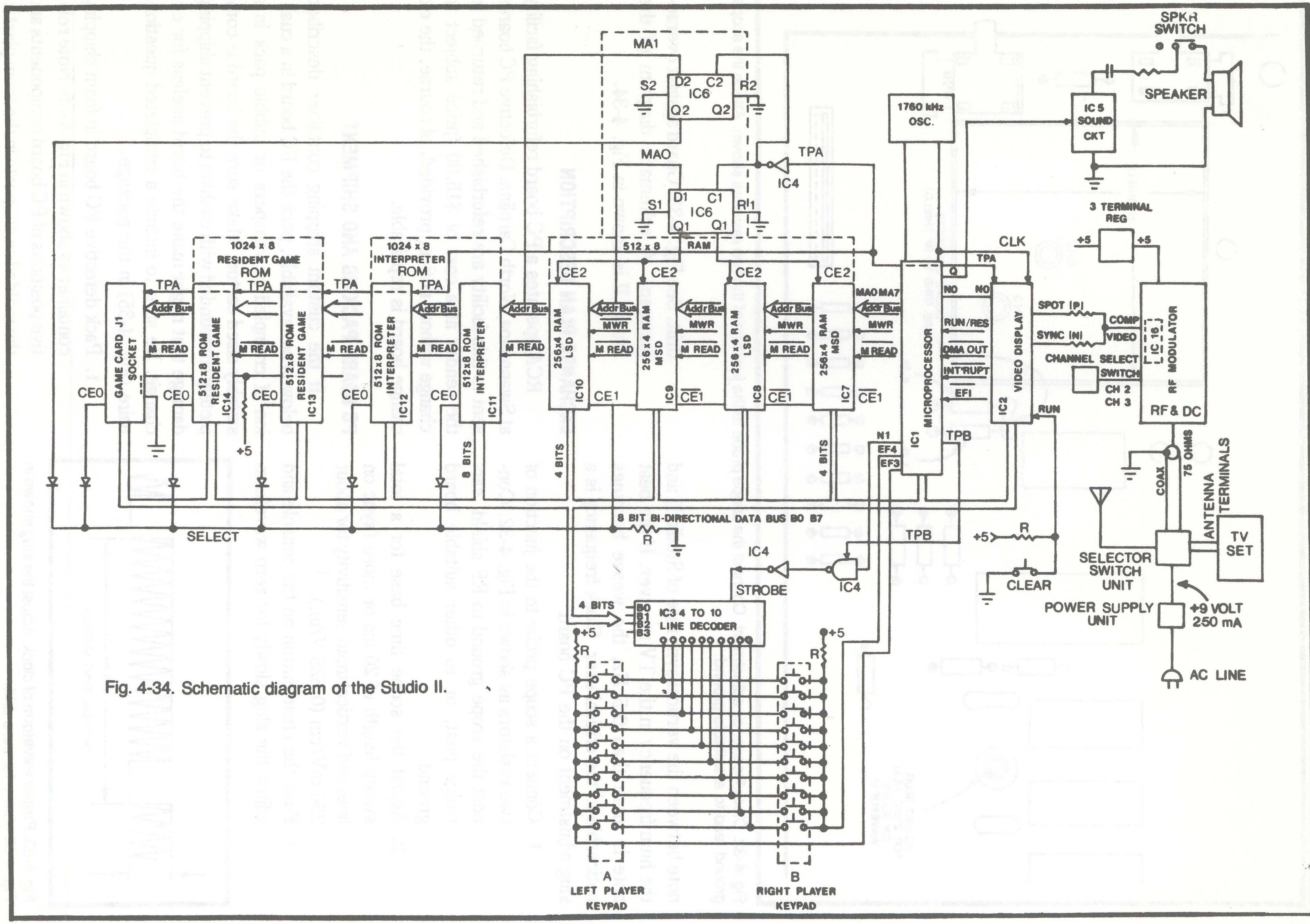



Fig. 4-34. Schematic diagram of the Studio II.

Please pack completed questionnaire in container with defective board with check or money order for $15. (Price subject to change without notice.)

Studio II Serial No. ______________

Please describe defect symptom(s). (No display, partial display, no sound, etc.)

______________________________

______________________________

______________________________

Defect: Intermittent ☐ Continuous ☐

Note: For in-warranty board exchange, include RCA Form PA737 "Repair Report".

RETURN SHIPPING LABEL

Firm Name ______________

Firm Address ______________

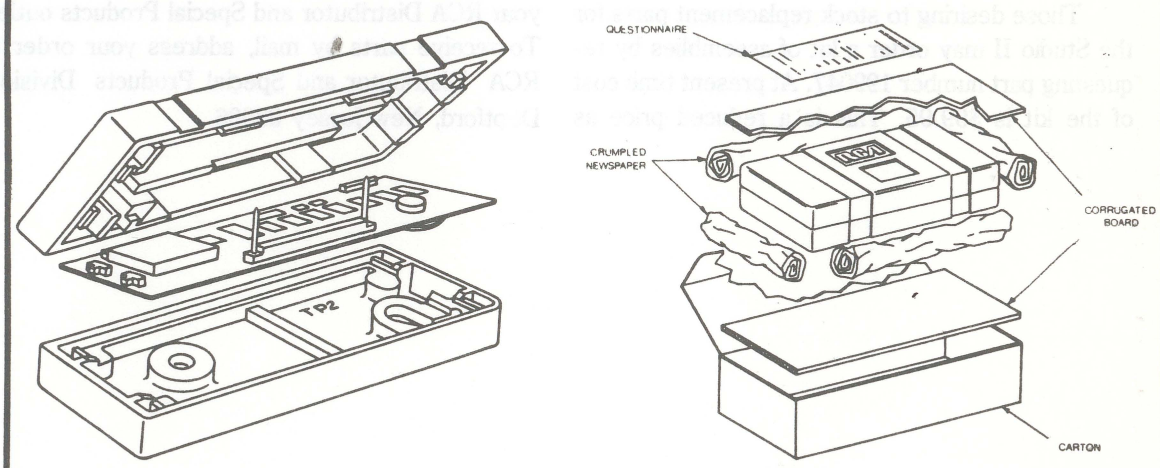
City ______ State ____ Zip ______

Attn: ______________

Fig. 4-35. Proper packing method for returning PC boards under the exchange plan.

If two halves of foam packing fail to mate easily, reverse relative position of one to another.

2. Pack the foam enclosure in a carton. Use crumpled newspapers as a cushion around foam enclosure.




## Replacement Parts and Accessories

| Description | Stock No. |
|---|---|
| PC Board (less coaxial cable, packed in reusable shipping carton) | 742463 |
| Cable Assembly | 742421 |
| Power Unit Assembly (incl. cord and plug) | 18V101 |
| Selector Switch Assembly | 18V102 |
| Keyboard Assembly | 742458 |
| Speaker, 2.24-inch diameter | 742448 |
| LED Indicator (incl. plastic holder) | 742461 |
| "Clear" Switch | 742459 |

| Description | Stock No. |
|---|---|
| Pushbutton for "Clear" Switch | 742460 |
| Rubber Feet (Package of 4) | 742462 |
| "Tester I" Test Cartridge[2] | 5009339 |
| Power Unit (for use with "Tester I") | 5008333 |
| Console Housing, Upper Half | (Dwg. No. 1809952) |
| Console Housing, Lower Half | (Dwg. No. 1809951) |
| Dress Plate (LED Indicator and "Clear" button) | (Dwg. No. 1808321-1) |
| Dress Plate ("Studio II") | (Dwg. No. 1808319-1) |

[2] Requires special power unit Stock No. 5008333

Fig. 4-36. Studio II PC board exchange questionaire.

3. Fill in all blanks on questionnaire, particularly those indicating abnormal symptoms (questionnaire packed with refurbished board). Pack completed questionnaire on outside of upper corrugated filler as shown and pack in carton.
4. Include check or money order for $15.00 (subject to change without notice). A refurbished PC board will be shipped to the address you supply on the questionnaire packed with defective board.
5. Ship prepaid (Parcel Post or UPS) to: Studio II PC Board Refurb. Dept., RCA Distributor & Special Products Div., Old Bee Tree Road Swannanoa, North Carolina 28778

## SERVICE PARTS KIT

Those desiring to stock replacement parts for the Studio II may order a kit of assemblies by requesting part number 199047. At present time cost of the kit is $99.95. This is a reduced price as compared to $122.90 if the parts were purchased individually. The kit includes the following:

| Qty | Description | Number |
|---|---|---|
| 2 | PC board (less coax) | 742463* |
| 2 | Coaxial cable asm | 742421 |
| 1 | Selector switch asm | 18V102 |
| 1 | Power supply unit | 18V101 |
| 3 | Keyboard asm | 742458 |
| 2 | Speaker | 742448 |
| 2 | LED power ind w/holder | 742461 |
| 3 | Clear switch | 742459 |
| 3 | Pushbutton (clear sw) | 742460 |
| 1 | Set of rubber feet | 742462 |

*—Includes reusable shipping carton for each board.

## REPLACEMENT PARTS

The parts list for the Studio II is shown in Fig. 4-36. When requesting parts, give the model of the unit (18V100), a description of the part, and the RCA stock number. Parts can be obtained locally at your RCA Distributor and Special Products outlet. To receive parts by mail, address your order to RCA Distributor and Special Products Division, Deptford, New Jersey 08096.

# CHAPTER 5

# GENERAL INSTRUMENT GAME CHIPS

Although many brand names of video games are appearing on the consumer market these days, only a few manufacturers actually produce the heart of the device, the microprocessor. General Instrument Corporation is in the IC business, supplying game chips to countless manufacturers of video games. And with the many variations of games, it is not enough to have one microprocessor for all-around use, even though one chip can function in several capacities.

In this chapter we will examine several game chips produced by General Instrument Corporation. Among them is the ever-popular AY-3-8500-1 chip used in most of the low-priced games. It is used by Magnavox, Radio Shack, and several others.

Our examination of these chips will not be at an engineering level. That is, we will not discuss the construction and internal circuitry of the game chip, only its functions and control points. It is really not necessary to know what is inside the chip since we replace it, when defective, as a unit.

In this chapter we will look at the following game and converter chips:

| GAME | NUMBER |
|---|---|
| Ball & Paddle I | AY-3-8500/8500-1 |
| Ball & Paddle IA | AY-3-8550/8550-1 |
| Color Converter I | AY-3-8515-1 |
| Ball & Paddle II | AY-8600/8600-1 |
| Color Converter II | AY-3-8615-1 |
| Battle I | AY-8700/8700-1 |
| GIMINI | AY-3-8900/8900-1, CP1610, RO-3-9316A, RO-3-20480, and RAM |

## BALL & PADDLE I

## AY-3-8500 & AY-3-8500-1

The AY-3-8500 and AY-3-8500-1 circuits have been designed to provide a TV video game function which gives active entertainment using a standard domestic TV receiver. The AY-3-8500 is the Australian and European version for a 625-line raster, while the AY-3-8500-1 is the American and Canadian version for a 525-line raster.

The IC is intended to be battery powered and a minimum number of external components are required to complete the system. A system diagram is shown in Fig. 5-1.

### GAME FEATURES

- Six selectable games:
  - Tennis
  - Soccer (hockey)
  - Squash
  - Practice
  - Rifle 1
  - Rifle 2
- 625-line (AY-3-8500) and 525-line (AY-3-8500-1) versions
- Automatic scoring

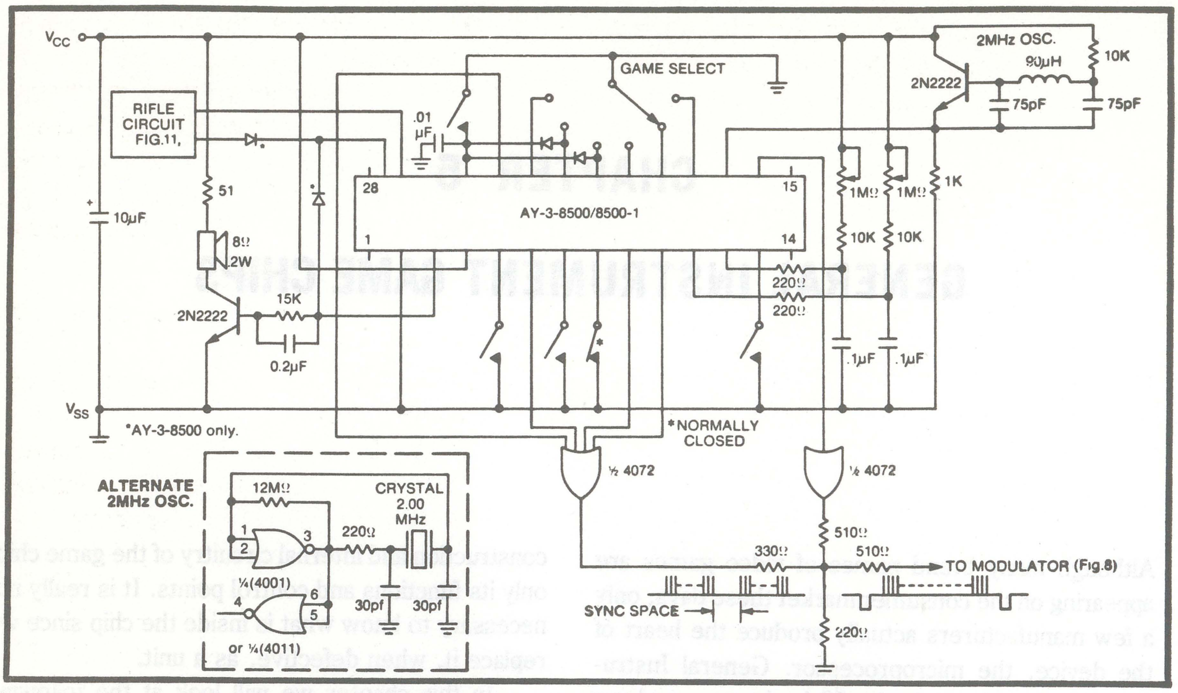



Fig. 5-1. System diagram for the AY-3-8500/8500-1 game chip.

- Score display on screen, 0–15
- Selectable bat size
- Selectable ball speed
- Selectable angles
- Automatic or manual ball serve
- Realistic sounds
- Shooting forwards in soccer/hockey game
- Visually defined area for all ball games
- Full color capabilities

## PIN FUNCTIONS

A top view of the AY-3-8500/8500-1 28-pin DIP is shown in Fig. 5-2. Notice that each pin of the IC diagram is labelled as to what its function is. Expanding this information a bit, we will now take a closer look at what takes place:

- Pin 1—No connection. Do not use this pin as a tie point.
- Pin2—$V_{ss}$ (negative power supply). Ground the chassis to this pin.
- Pin 3—Sound output. A hit is a 32 ms pulse of a 976 Hz tone. A boundary reflection is a 32 ms pulse of a 1.95 kHz tone. See Fig. 5-3.
- Pin 4—$V_{cc}$ (positive power supply).
- Pin 5—2/4 angles input. When this input is left open two rebound angles are allowed. When it is connected to 0V (logic *zero*) four rebound angles are allowed.
- Pin 6—Ball output. The video signal representing the ball or target is outputted on this pin. See Fig. 5-3.
- Pin 7—Ball speed input. When this input is left open, low speed is selected. In this mode the ball takes 1.3 seconds to traverse the screen. When it is connected to 0V (logic *zero*) the high-speed option is selected. The ball then takes 0.65 seconds to traverse the screen.

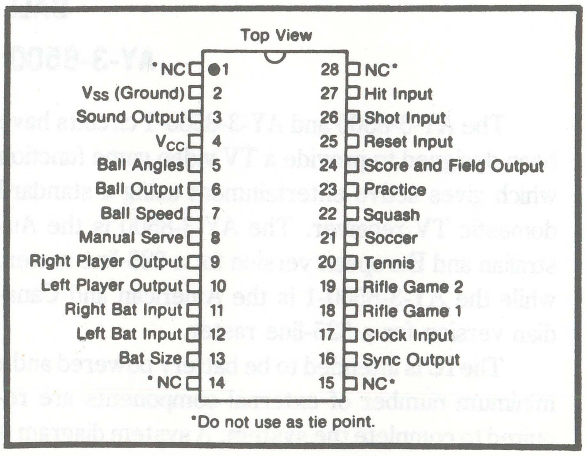



Fig. 5-2. Pin layout of the AY-3-8500/8500-1 game chip.

- Pin 8—Manual service. When this input is connected to 0V (logic *zero*) the play is restarted automatically after each score. When it is left open, play stops after each score. The game can then be restarted by connecting this input to ground momentarily.
- Pin 9—Right player output. The video signal representing the right-hand player is outputted on this pin. See Fig. 5-3.
- Pin 10—Left player output. The video signal representing the left-hand player is outputted on this pin. See Fig. 5-3.
- Pin 11—Right bat input. A capacitor and variable resistor connected to this input control the vertical position of the right-hand player. Use a 10K resistor in series with the potentiometer. See Fig. 5-3 for RC discharge waveform.
- Pin 12—Left bat input. A capacitor and variable resistor connected to this pin controls the vertical position of the left-hand player. Use a 10K resistor in series with the potentiometer. See Fig. 5-3 for RC discharge waveform.
- Pin 13—Bat size input. This pin is left open circuit (logic *one*) to select large bats and connected to Vss (logic *zero*) to select small bats. For a 19-inch TV screen, the large bats are 1.9 inches and the small bats are 0.95 inches high.
- Pin 14—No connection. Do not use this pin as a tie point.
- Pin 15—No connection. Do not use this pin as a tie point.
- Pin 16—Sync output. The TV vertical and horizontal sync signals are outputted on this pin. See Fig. 5-3 for sync waveform.
- Pin 17—Clock input. The 2 MHz master timing clock pulses are fed to this pin. The exact frequency is 2.012160 MHz ±20 kHz.
- Pin 18—Rifle 1. This input is normally left open (logic *one*) and is connected to Vss (logic *zero*) when it is the desired game.

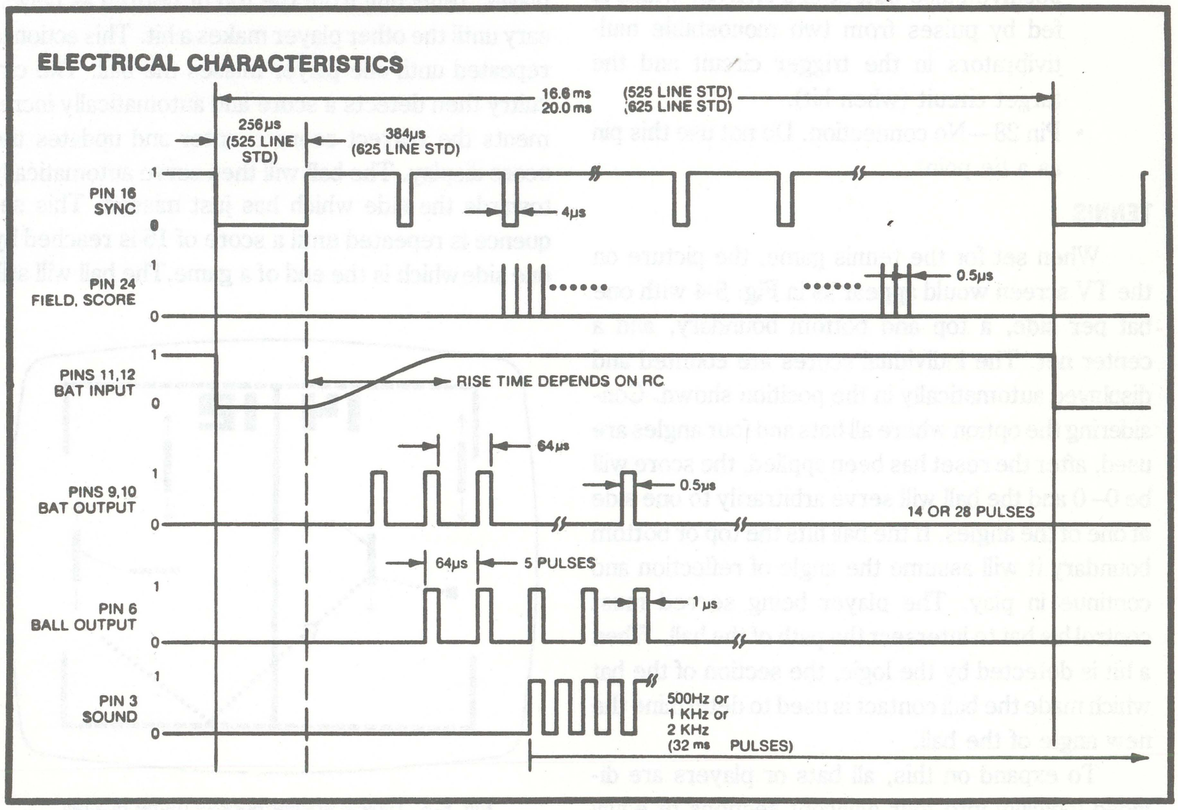



Fig. 5-3. Output waveforms from the AY-3-8500/8500-1 game chips.

- Pin 19—Rifle 2. Connection method is the same as for pin 18.
- Pin 20—Table tennis. Connection method is the same as for pin 18.
- Pin 21—Soccer (hockey). Connection method is the same as for pin 18.
- Pin 22—Squash. Connection method is the same as for pin 18.
- Pin 23—Practice. Connection method is the same as for pin 18.
- Pin 24—Score and field output. The video signal representing the score and playing field is outputted on this pin. See Fig. 5-3 for a typical waveform.
- Pin 25—Reset input. This input is normally left as an open circuit. When it is desired to reset the score counter and start a new game, this pin is momentarily connected to ground ($V_{SS}$).
- Pin 26—Shot input. This input is driven by the output of a monostable multivibrator, located in the external rifle circuit, to indicate that a shot has been fired.
- Pin 27—Hit input. This input is driven by a positive pulse output of a NAND, which is fed by pulses from two monostable multivibrators in the trigger circuit and the target circuit (when hit).
- Pin 28—No connection. Do not use this pin as a tie point.

## TENNIS

When set for the tennis game, the picture on the TV screen would appear as in Fig. 5-4 with one bat per side, a top and bottom boundary, and a center net. The individual scores are counted and displayed automatically in the position shown. Considering the option where all bats and four angles are used, after the reset has been applied, the score will be 0–0 and the ball will serve arbitrarily to one side at one of the angles. If the ball hits the top or bottom boundary it will assume the angle of reflection and continue in play. The player being served must control his bat to intersect the path of the ball. When a hit is detected by the logic, the section of the bat which made the ball contact is used to determine the new angle of the ball.

To expand on this, all bats or players are divided logically into four adjacent sections of equal length. When using the four angle option, it is the quarter-section of the bat which actually hits and determines the new direction for the ball.

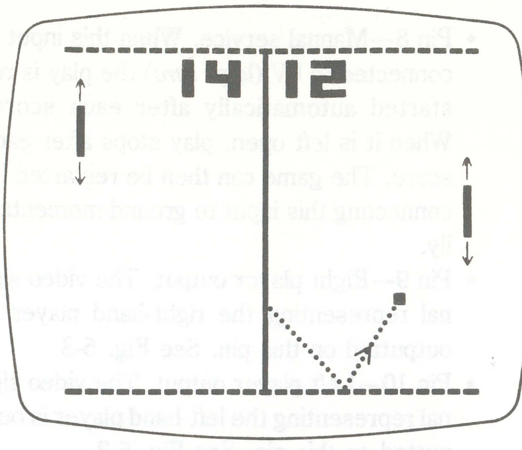


Fig. 5-4. Typical tennis game display.

The direction does not depend upon the previous angle of incidence. With the two-angle option, the top and bottom pairs of the bats are summed together and only the two shallower angles are used to program the new direction for the ball.

The ball will then traverse towards the other player, reflecting from the top or bottom as necessary until the other player makes a hit. This action is repeated until one player misses the ball. The circuitry then detects a score and automatically increments the correct score counter and updates the score display. The ball will then serve automatically towards the side which has just missed. This sequence is repeated until a score of 15 is reached by one side which is the end of a game. The ball will still

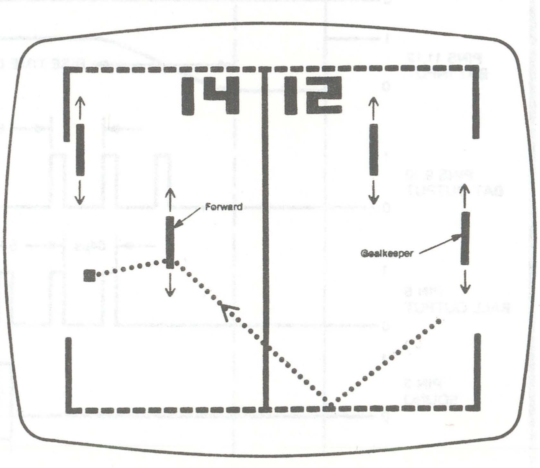


Fig. 5-5. Typical soccer/hockey game display.

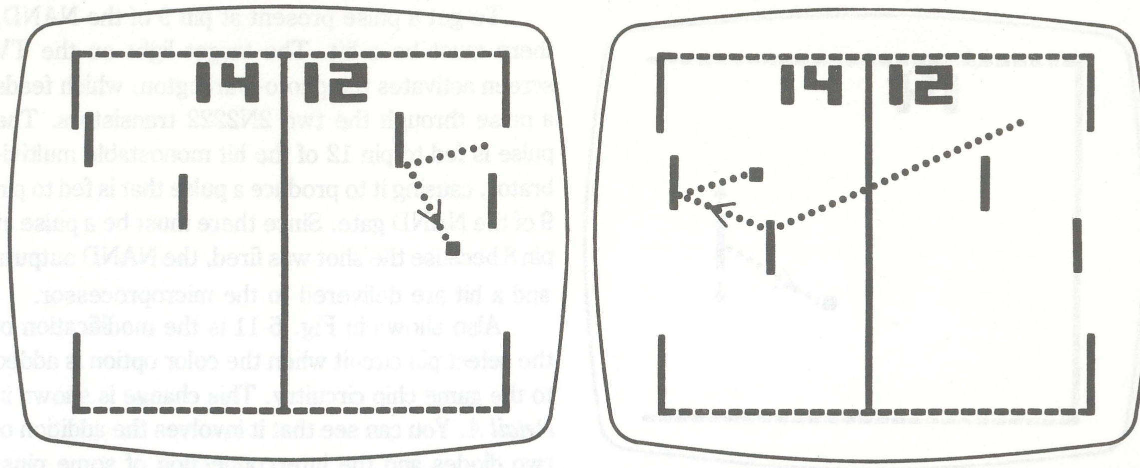



Fig. 5-6. Action shots for soccer/hockey. A return of a goal save is displayed on the right and shooting a forward is displayed on the right.

bounce around but no further hits or scores can be made. While the game is in progress, three audio tones are fed out by the circuit to indicate top and bottom reflections, bat hits, and scores.

## SOCCER/HOCKEY

The soccer/hockey game is shown in Fig. 5-5. With this game each player has a goalie and a forward. The layout is such that the goalie is in his normal position and the forward is positioned in the opponent's half of the playing area. When the game starts, the ball will appear travelling from one goal line towards the other side. If the opponent's forward can intercept the ball (see Fig. 5-6A) he can shoot it back towards the goal. If the ball is missed it will travel to the other half of the playing area. The first team's forward will have the opportunity of intercepting the ball and redirecting it forward at a new angle according to the player section which is used (see Fig. 5-6B). If the ball is saved by the goalie or it reflects back from the end boundary, the same forward will have the opportunity to intercept the outcoming ball and divert it back towards the goal.

A score is made by shooting the ball through the defined goal area. The scoring and game control is done automatically as for the tennis game. The same audio signals are used to add a realistic atmosphere to the game.

## SQUASH

This game is illustrated in Fig. 5-7. There are two players who alternately hit the ball into the court. The right-hand player is the one that hits first, then it goes over to the left-hand player. Each player is enabled alternately to insure that the proper sequence of play is followed.

## PRACTICE

This game is similar to squash, except that there is only one player (see Fig. 5-8).

## RIFLE 1 & RIFLE 2

The rifle shoot game 1 is illustrated in Fig. 5-9. It has a large target which bounces randomly about the TV screen. A photocell within the rifle is aimed at the target. When the trigger is pulled the shot counter is incremented. If the rifle is on target the hit counter is incremented, a hit audio sound is generated, and the target is blanked for a short

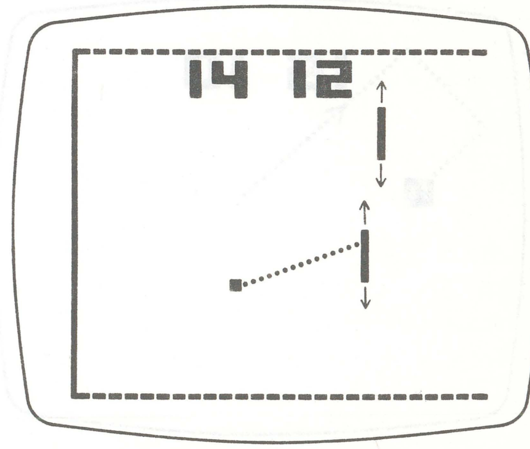



Fig. 5-7. Typical squash display.

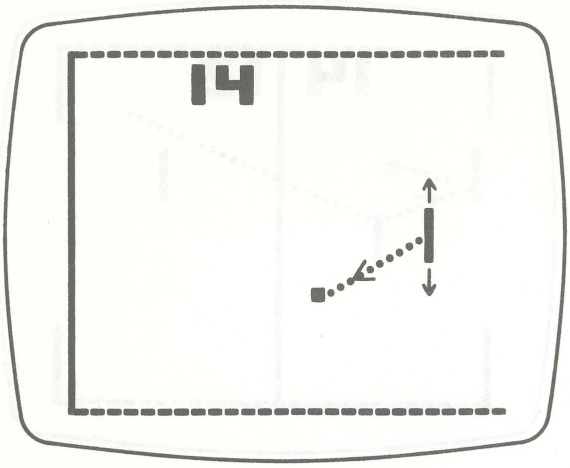



Fig. 5-8. Typical practice display.

duration. After 15 shots the game can still continue but without additional scoring.

Rifle game 2 is illustrated in Fig. 5-10. The ball traverses the screen from left to right as shown under the control of the manual serve button. Other than the ball travel, the operation of this game is the same as Rifle 1.

A typical circuit for the external rifle circuit is shown in Fig. 5-11. When the trigger is pulled, a pulse is fed from the flip-flop, formed by the two sections of the 4011, to the monostable vibrator (pin 4 of the 4098 or the 14528CL). This positive pulse output is fed to pin 26 of the AY-3-8500/8500-1 and to pin 8 of another section of the 4011. If there is a pulse at pin 9 of the same NAND gate, there is an output fed to pins 12 and 13, which outputs a positive pulse to pin 27 of the microprocessor.

To get a pulse present at pin 9 of the NAND, there must be a hit. The target light on the TV screen activates the photo-Darlington, which feeds a pulse through the two 2N2222 transistors. The pulse is fed to pin 12 of the hit monostable multivibrator, causing it to produce a pulse that is fed to pin 9 of the NAND gate. Since there must be a pulse at pin 8 because the shot was fired, the NAND outputs and a hit are delivered to the microprocessor.

Also shown in Fig. 5-11 is the modification of the select pin circuit when the color option is added to the game chip circuitry. This change is shown in *Detail A*. You can see that it involves the addition of two diodes and the interconnection of some pins. This will be covered later in the AY-3-8515-1 section of this chapter.

## FOUR-PLAYER CONFIGURATION OPTION

With this option, the basic two-player tennis game can be expanded to four-player doubles. Each player is capable of playing the full width of the court. A display of this setup is shown in Fig. 5-12. A variation of this game allows a three-player handicap game with two players against one.

A schematic of the additional circuitry is shown in Fig. 5-13. The circuit employs a NOR gate used as an inverter, a D-type flip-flop, and a quad bilateral switch. The CD4001 inverter provides the CD4013 flip-flop with a logic *one* during periods of no vertical sync. Notice that the set and reset inputs are held at logic *zero* to insure that the $Q$ and $\bar{Q}$ output are complementary at all times. These outputs are used to multiplex the CD4016 bilateral switch. The $Q$

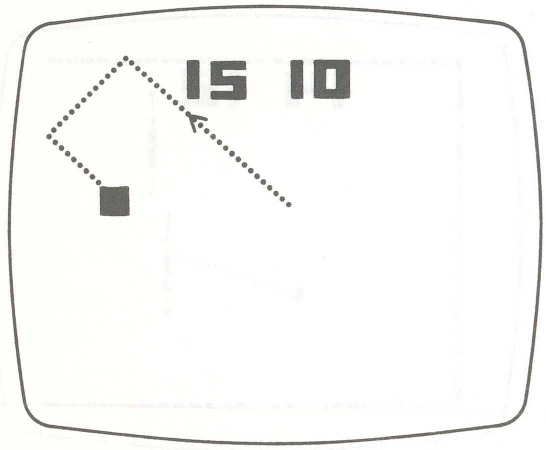



Fig. 5-9. Typical rifle 1 game display.

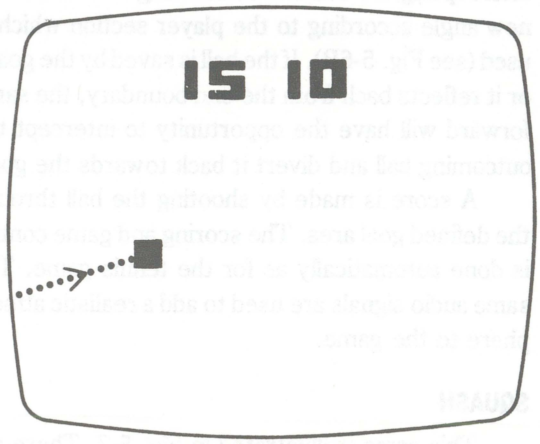



Fig. 5-10. Typical rifle 2 game display.

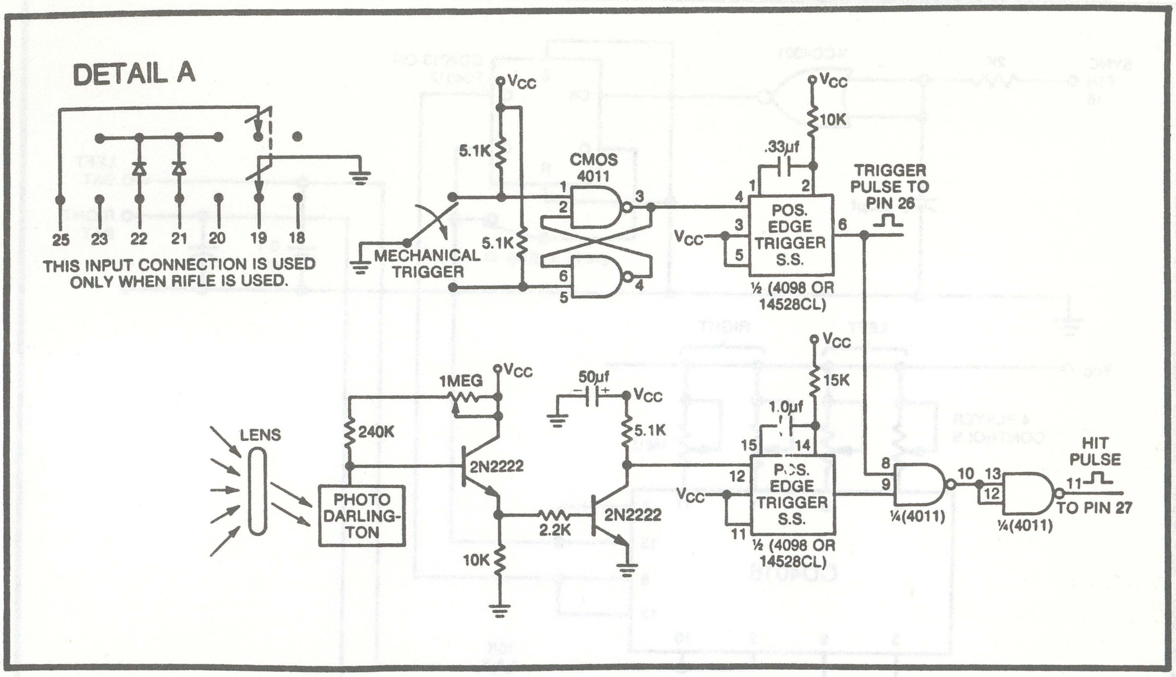



Fig. 5-11. Bowling alley display. Pressing the indicated keys on keyboard A releases the ball in the fashion shown.

output of the flip-flop is connected to the control pin of one right player and one left player, pins 5 and 13. The same conditions exist for the $\bar{Q}$ output. By connecting the quad bilateral switch in this manner, each player control (1M pot) becomes operational during a 30 Hz interval. That is, it takes two vertical sync pulses before all four players have had control. During the first time interval, one of the right players and one of the left players are activated until the next sync pulse comes along. At this point the CD4013 flip-flop is clocked when the pulse terminates. Then the other two controls are activated.

When this option is used, the original 2-player controls must not be connected to the right and left bat inputs. A 2/4-player switch is used to revert to the original game format. Notice that even with this configuration, the RC time constants of the player controls remain the same, a 1M pot, a 10 K resistor, and a 0.1 $\mu$F capacitor.

## RANDOM BALL SPEED/RANDOM ANGLES OPTION

To enhance the excitement and challenge of the various games, this option provides random variations of the ball speed and random changes in the ball rebound angle as the games are being played. A representation of what the display looks like is shown in Fig. 5-14.

Without this option, the angular motion of the ball is controlled by supplying a logic *one* to pin 5 of the microprocessor for the 2-angle mode or a logic *zero* to the same pin for the 4-angle mode. With this option, the microprocessor might be in either of these angular modes at any time.

Ball speed is normally determined by supplying a logic *one* to pin 7 of the microprocessor for the slow speed mode or a logic *zero* to the pin for the fast speed mode. With this option, the microprocessor is engaged in either ball speed mode at random.

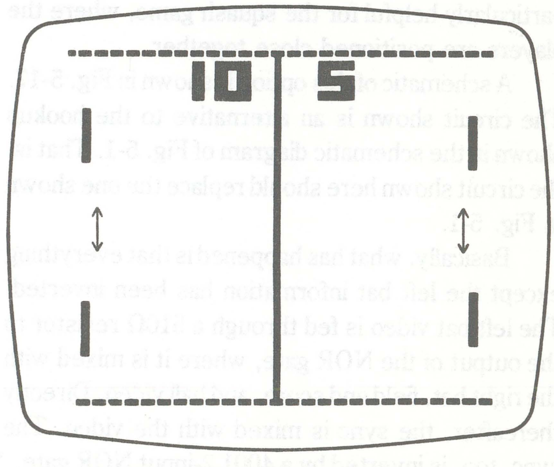



Fig. 5-12. Typical four-player display.

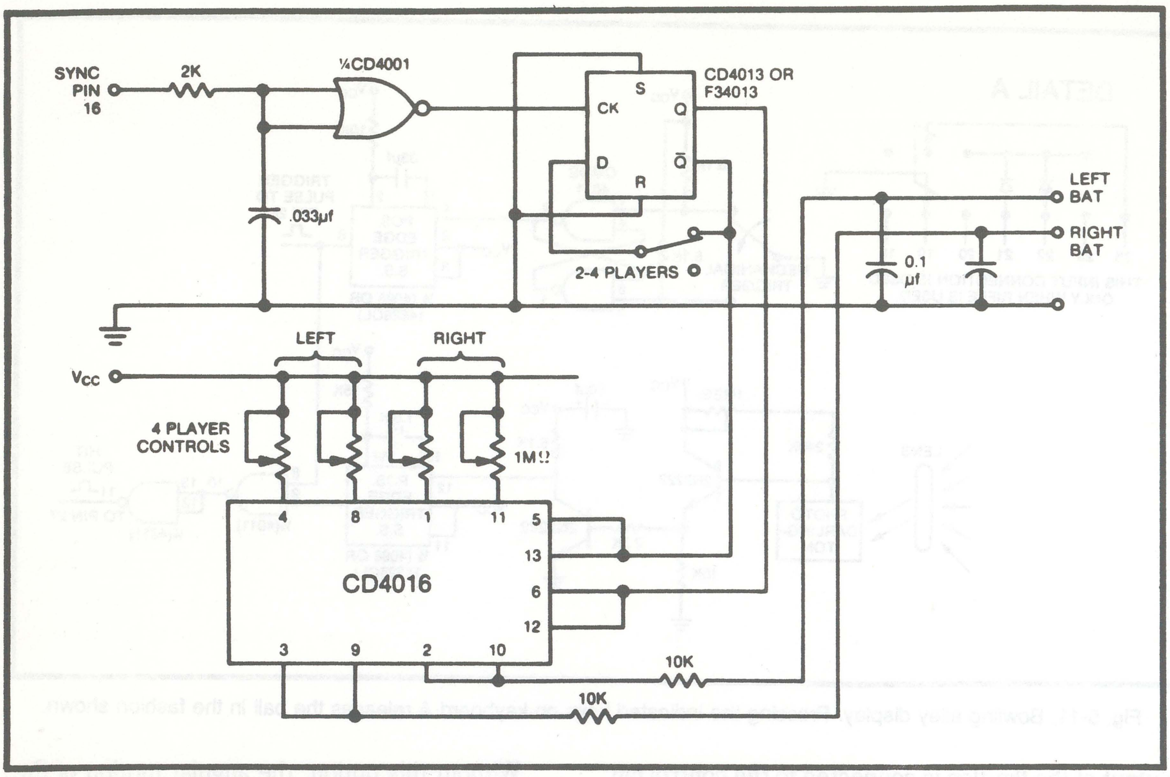



Fig. 5-13. Additional circuitry required by the AY-3-8500/8500-1 game chip when the four-player option is desired.

A schematic diagram of this option is shown in Fig. 5-15. You can see that the original fast/slow ball speeds and 2/4 angles can still be selected. The flip-flops used here are the 4013 type.

## B&W BATS/GRAY FIELD OPTION

This option (Fig. 5-16) provides an added factor for player team recognition. The field or court is produced as a gray background with the bats of one team in black and the other in white. The option is particularly helpful for the squash game, where the players are positioned close together.

A schematic of this option is shown in Fig. 5-17. The circuit shown is an alternative to the hookup shown in the schematic diagram of Fig. 5-1. That is, the circuit shown here should replace the one shown in Fig. 5-1.

Basically, what has happened is that everything except the left bat information has been inverted. The left bat video is fed through a 510Ω resistor to the output of the NOR gate, where it is mixed with the right bat, field and score, and ball video. Directly thereafter, the sync is mixed with the video. The sync, too, is inverted by a 4001 2-input NOR gate.

## COLOR CONVERTER OPTION

The AY-3-8500-1 can be adapted for full color operation by adding the AY-3-8515-1 color converter. This option is covered in full detail later in this chapter. But for now a simple rundown of alterations is in order.

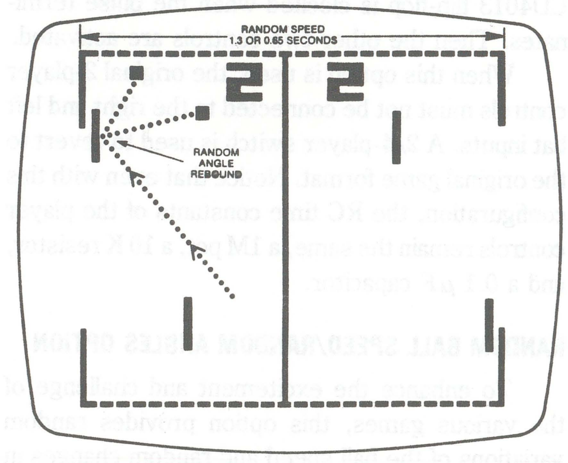



Fig. 5-14. Random ball speed/random angles display.

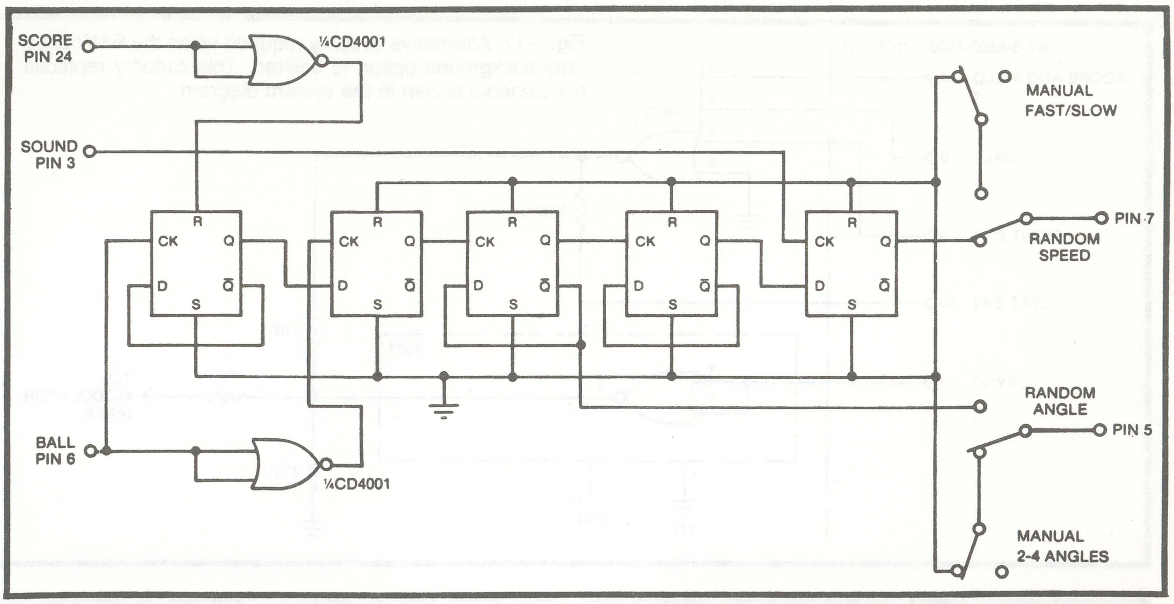



Fig. 5-15. Typical doodle display. Pressing the clear button and key A1 displays a single dot at the lower-left corner of the TC screen.

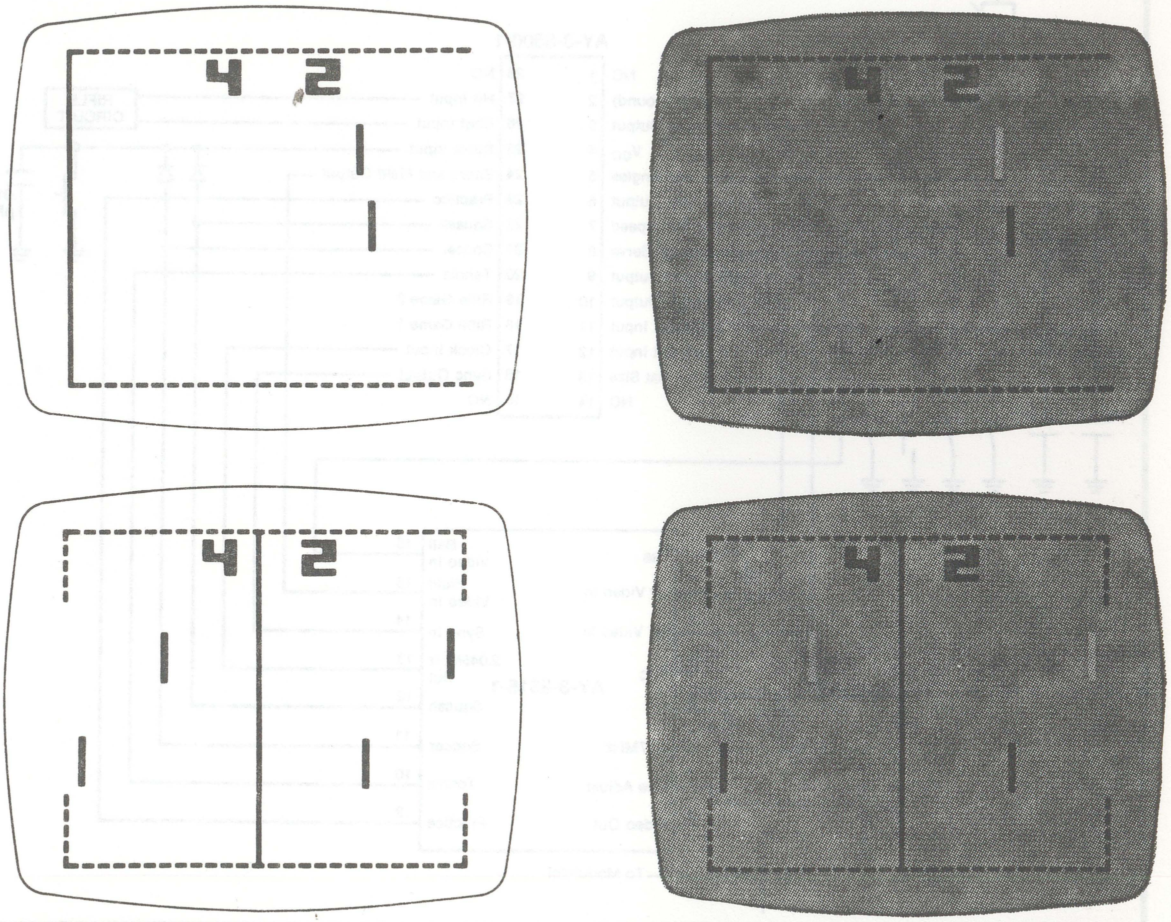



Fig. 5-16. Test made using the keyboard and built-in addition game. By entering the wrong answer, the beeper sounds, indicating that key operational.

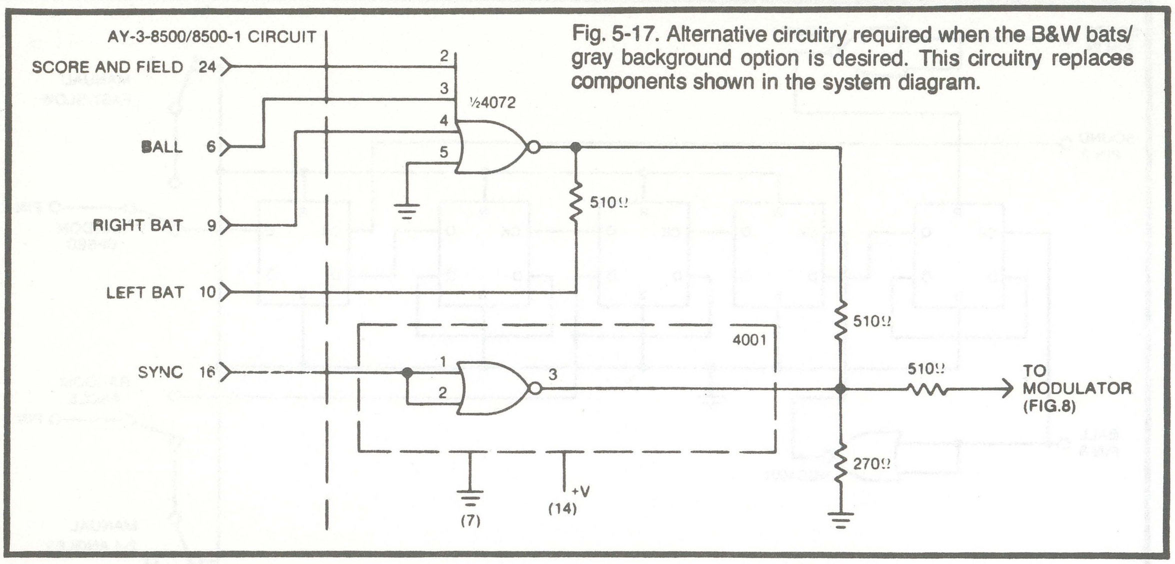



Fig. 5-17. Alternative circuitry required when the B&W bats/gray background option is desired. This circuitry replaces components shown in the system diagram.

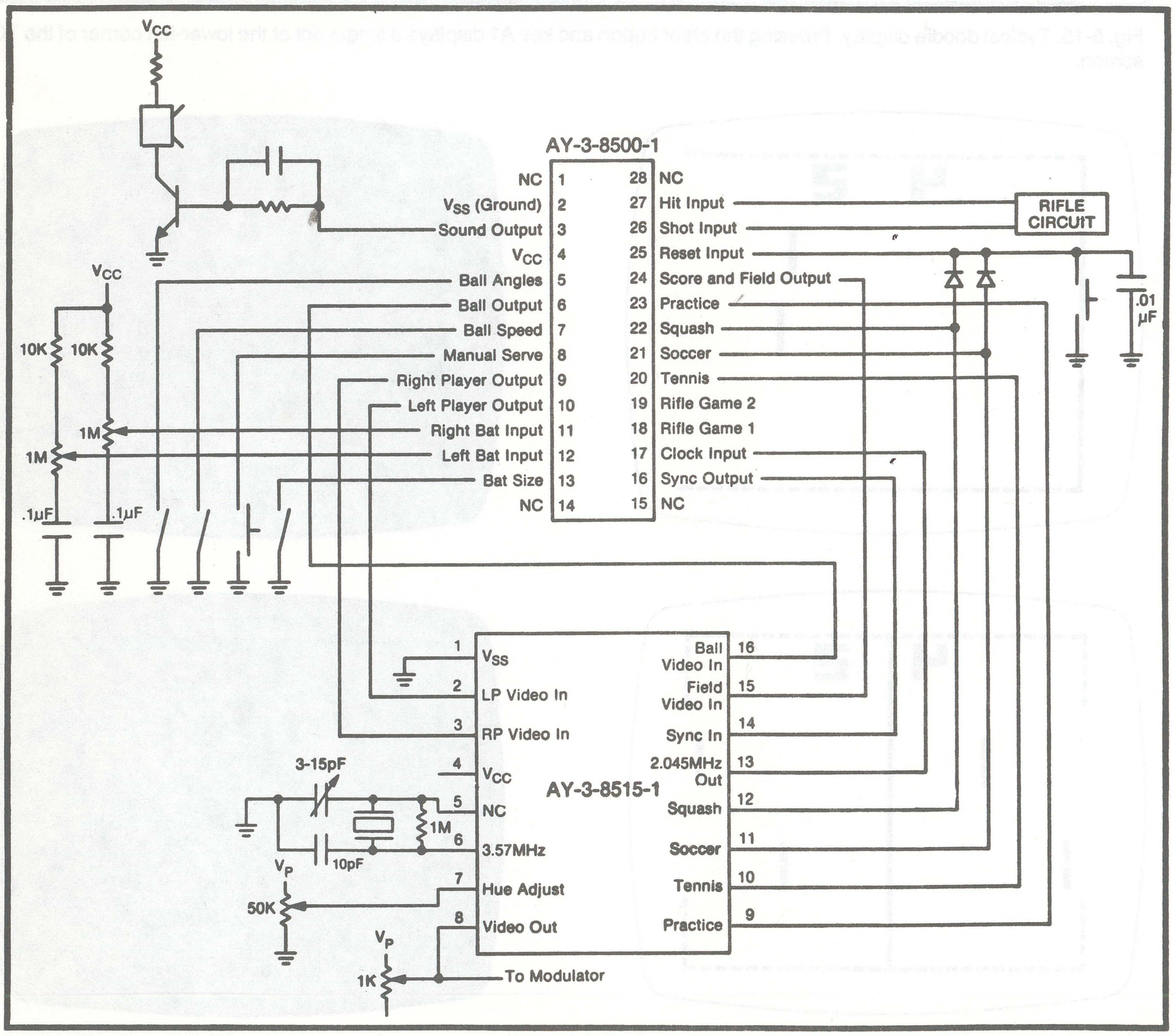



Fig. 5-18. Schematic diagram of the color converter option for the AY-3-8500-1 game chip. The AY-3-8515-1 converter chip takes over the function of the clock, among other things. This system applies only for the 525-line version.

A schematic diagram of the AY-3-8500-1/AY-3-8515-1 combination is shown in Fig. 5-18. Notice that all control pin connections remain the same as for the B&W setup. The major difference in the color setup is the 3.579 MHz clock frequency. The AY-3-8515 chip also generates a 2.045 MHz clock output for the game chip so that no additional circuitry is required.

## BALL & PADDLE IA
## AY-3-8550 & AY-3-8550-1

This game chip is nearly the same as its predecessor, the AY-3-8500/8500-1. Like its predecessor, Ball & Paddle IA is available in a 525-line version (AY-3-8550-1) and a 625-line version (AY-3-8550).

The circuit (Fig. 5-19) is intended to be battery powered, and a minimum number of external components are required to complete the system.

### GAME FEATURES

- Six selectable games
  - Tennis
  - Soccer (hockey)
  - Squash
  - Practice
  - Rifle 1
  - Rifle 2
- 625-line (AY-3-8550) and 525-line (AY-3-8550-1) versions
- Selectable horizontal motion
- Special composite outputs for color coding players, ball, score, and boundaries
- Automatic scoring
- Score display on TV screen, 0–15
- Selectable bat size
- Selectable angles
- Selectable ball speed
- Automatic or manual ball serve
- Realistic sounds
- Shooting forwards in soccer/hockey game
- Visually defined area for all ball games
- Score color coded for each player
- Ball output coded to player in squash

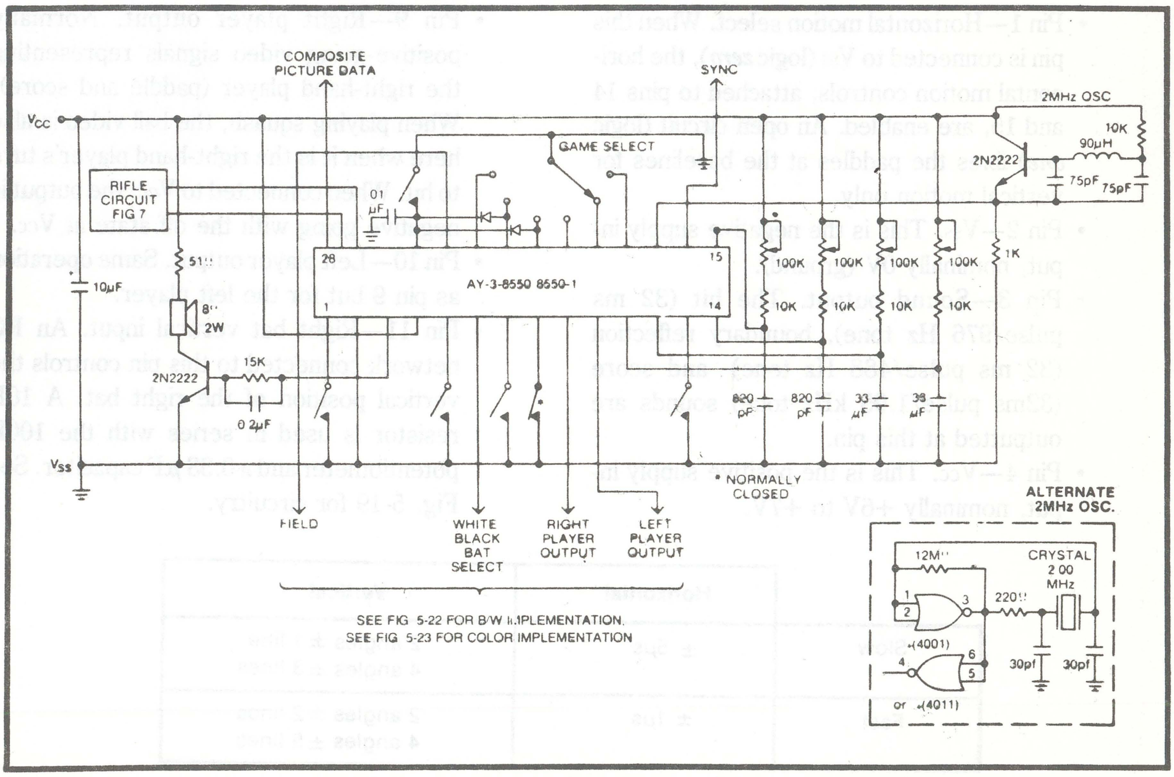



Fig. 5-19. System diagram of the AY-3-8550/8550-1 game chip.

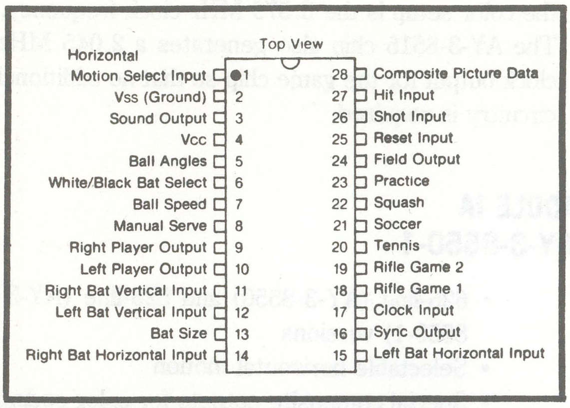



Fig. 5-20. Pin layout of the AY-3-8550/8550-1 game chip.

- Practice game scores both hits and misses
- Composite picture data on one pin and individual video signals for color
- Pin compatible with the AY-3-8500/8500-1

## PIN FUNCTIONS

A top view of the AY-3-8550/8550-1 28-pin DIP is shown in Fig. 5-20. Notice that each pin of the IC diagram is referenced as to what function it performs. Expanding this basic information a bit, we will now examine the function and operation of each pin on the AY-3-8550/8550-1:

- Pin 1—Horizontal motion select. When this pin is connected to Vss (logic *zero*), the horizontal motion controls, attached to pins 14 and 15, are enabled. An open circuit (logic *one*) fixes the paddles at the baselines for vertical motion only.
- Pin 2—Vss. This is the negative supply input, nominally 0V (ground).
- Pin 3—Sound output. The hit (32 ms pulse/976 Hz tone), boundary reflection (32 ms pulse/488 Hz tone) and score (32ms pulse/1.95 kHz tone) sounds are outputted at this pin.
- Pin 4—Vcc. This is the positive supply input, nominally +6V to +7V.
- Pin 5—Ball angles. This input is left open circuit (logic *one*) to select two rebound angles and connected to Vss (logic *zero*) to select four rebound angles. When the two-angle selection is made they are at ±20° and ±40°. See Fig. 5-21.
- Pin 6—White/black bat select. When connected to Vcc (logic *one*), the right player is inverted for a black image. When pulled to Vss, the right player is white. See Figs. 5-22 and 5-23 for black-and-white implementation.
- Pin 7—Ball speed. When this input is left open circuit, low speed is selected. In this mode it takes 1.3 seconds to traverse the TV screen. When connected to $V_{ss}$ (logic *zero*), the high-speed option is selected, taking 0.65 seconds for the ball to traverse the TV screen.
- Pin 8—Manual serve. This input is connected to Vss (logic *zero*) for automatic serving. When left open circuit (logic *one*), the game stops after each score. The serve is initiated by momentarily connecting this input to Vss.
- Pin 9—Right player output. Normally positive-going video signals representing the right-hand player (paddle and score). When playing squash, the ball video is also here when it is the right-hand player's turn to hit. When connected to Vcc, the output is negative going with the off state at Vcc.
- Pin 10—Left player output. Same operation as pin 9 but for the left player.
- Pin 11—Right bat vertical input. An RC network connected to this pin controls the vertical position of the right bat. A 10K resistor is used in series with the 100K potentiometer and a 0.33 μF capacitor. See Fig. 5-19 for circuitry.

| | Horizontal | Vertical |
|---|---|---|
| Slow | ± .5μs | 2 angles ±1 line<br>4 angles ±3 lines |
| Fast | ± 1μs | 2 angles ±2 lines<br>4 angles ±5 lines |

Fig. 5-21. Angular motion of the ball.

- Pin 12—Left bat vertical input. Same as pin 11 but for the left bat.
- Pin 13—Bat size. This input is left open circuit (logic *one*) to select large bats and connected to Vss (logic *zero*) to select small bats. For a 19-inch TV screen, the large bats are 1.9 inches and the small bats are 0.95 inches high.
- Pin 14—Right bat horizontal input. An RC network connected to this pin controls the horizontal position of the bats. A 10K resistor is used in series with a 100K potentiometer and a 820 pF capacitor. See Fig. 5-19 for circuitry.
- Pin 15—Left bat horizontal input. Same as pin 14 but for the left bat.
- Pin 16—Sync output. The TV vertical and horizontal sync signals are outputted on this pin. Sync must always be one of the signals included in the composite video fed to the modulator.
- Pin 17—Clock input. The 2 MHz master timing clock is inputted to this pin. The exact frequency is 2.012160 MHz ±20 kHz.
- Pin 18—Rifle game 1. This input is normally left open circuit (logic *one*) and connected to Vss (logic *zero*) to select it as the desired game.
- Pin 19—Rifle game 2. Same operation as pin 18.
- Pin 20—Tennis. Same operation as pin 18.
- Pin 21—Soccer/hockey. Same operation as pin 18.
- Pin 22—Squash. Same operation as pin 18.
- Pin 23—Practice. Same operation as pin 18.
- Pin 24—Field output. The field video signal is outputted on this pin.
- Pin 25—Reset. This input is connected momentarily to Vss (logic *zero*) to reset the score counters and start a new game. This pin is normally left open circuit.
- Pin 26—Shot input. This input is driven by a positive pulse output of a monostable multivibrator to indicate a shot by the rifle.
- Pin 27—Hit input. This input is driven by a positive pulse from a monostable multivibrator that is triggered by the shot input when the trigger is pulled and by a target hit if the shot is on target.
- Pin 28—Composite picture data. This positive-going output is the sum of the picture data for the bats, ball, field, and score. It can be used in lieu of the data on pins 9, 10, and 24. This signal and the sync are the only signals required for monochrome operation (see Fig. 5-22).

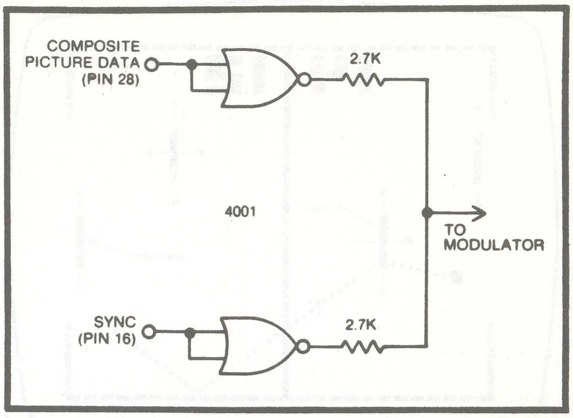



Fig. 5-22. B&W implementation using the composite video output data from pin 28.

## OPERATION OF GAMES

Basically, the operation of all the games for this chip is the same as for Ball & Paddle I (AY-3-8500/8500-1) with the addition of horizontal movement. Using soccer as an example, Fig. 5-24, you are now able to control horizontal movement of each forward

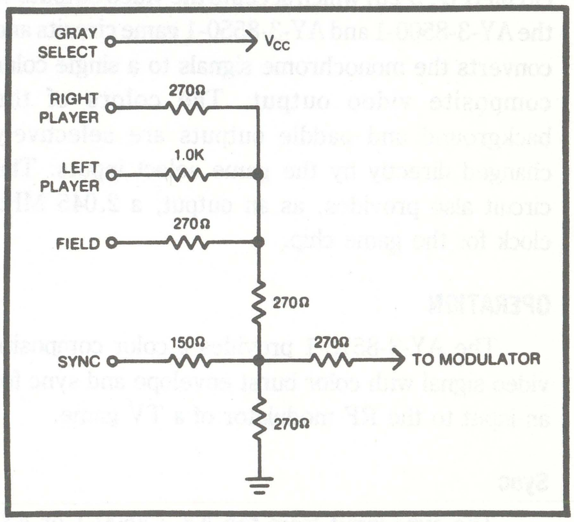



Fig. 5-23. B&W implementation using individual video outputs.

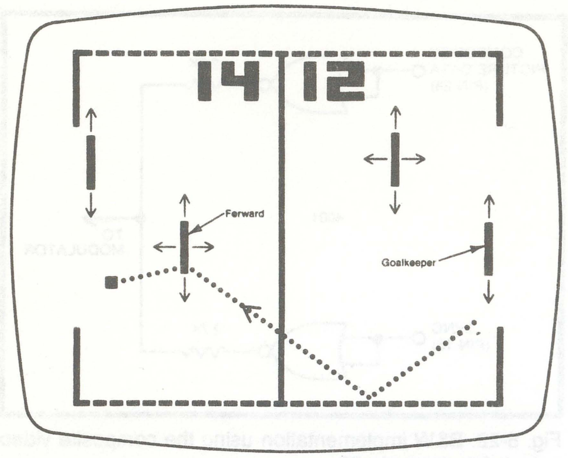



Fig. 5-24. Typical soccer display from the AY-3-8550/8550-1 game chip. Notice the horizontal control over the players.

as well as vertical movement. The goalie, however, still can be moved vertically. Tennis, squash, and practice include this feature also. Rifle1 and 2 games are identical to that of the AY-3-8500/8500-1.

### RIFLE

The rifle circuitry required for the AY-3-8550/8550-1 is identical to that used with the AY-3-8500/8500-1. A schematic diagram for the circuit is shown in Fig. 5-11. Basically, the rifle circuit depends on the outputs of two monostable multivibrators being fed to the 4011 NAND gate (pins 8 and 9). When this happens, as it does when a shot is fired and the target is hit, an output from the NAND gate is inverted and fed to pin 27, indicating that a hit has taken place.

To adjust the rifle circuitry, aim the rifle at the score on the TV screen. Adjust the 1M potentiometer in the collector circuit of the first 2N2222 for maximum voltage at pin 12 of the 4098 monostable multivibrator. This should be performed with the rifle at a distance of 6 feet. The voltage at pin 12 of the 4098 should be zero when there is no light on the screen.

### COLOR CONVERTER OPTION

The AY-3-8550-1 can be operated in conjunction with a color subcarrier chip, AY-3-8515-1, to display data in color on a home TV receiver. The operation of this companion chip will be covered in the next section of this chapter. A schematic diagram of this full color implementation is shown in Fig. 5-25. The major difference here is the master clock is operating at 3.57 MHz. The circuitry of the color chip provides a 2 HMz clock for video generation in the game chip.

## COLOR CONVERTER AY-3-8515-1

The AY-3-8515-1 is a single N-channel MOS circuit (Fig. 5-26) which accepts the video outputs of the AY-3-8500-1 and AY-3-8550-1 game circuits and converts the monochrome signals to a single color composite video output. The colors of the background and paddle outputs are selectively changed directly by the game select inputs. The circuit also provides, as an output, a 2.045 MHz clock for the game chip.

### OPERATION

The AY-3-8515-1 provides a color composite video signal with color burst envelope and sync for an input to the RF modulator of a TV game.

#### Sync

The sync input from the AY-3-8500-1 or AY-3-8550-1 is reconstructed in the color circuit and provides both front and back porches to insure correct operation in color TV circuits.

#### Color Burst

A color burst signal, containing 10 Hz of the 3.579 MHz color reference, is supplied after sync (Fig. 5-27). The color phase of the burst is internally selected by the game select inputs with respect to the phases of the background, right player, and left player so that different colors may be rendered for each game. This color change may be affected with no external components for ball and paddle games and only requires the addition of two diodes when target games are also selected.

The color burst is followed by an appropriate blanking interval so the TV set will not lock on to the background phase.

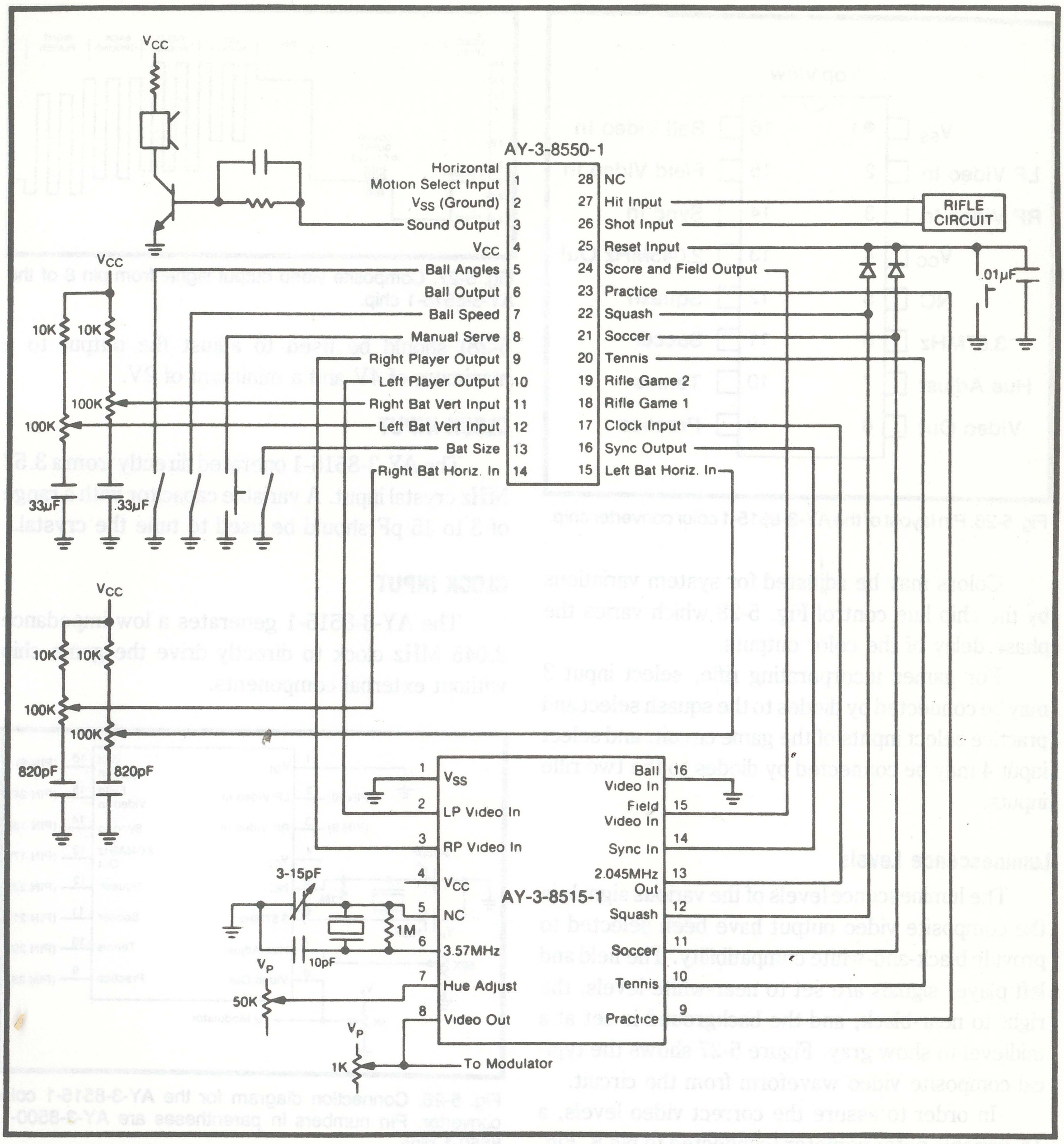



Fig. 5-25. Full color implementation for the AY-3-8550-1 using color converter AY-3-8515-1.

## Video Inputs

Four video inputs are provided on the AY-3-8515-1. These are: field and score, left player, right player, and ball. When operated with the AY-3-8550-1, the ball input should be grounded.

## Video Outputs

After sync, color burst, and blanking, the video consists of background, field and score, right player, left player, and ball. The ball output is always white. In the absence of other signals, the background is outputted.

The color outputs are:

| Select Input | Back-ground | Field | Right Player | Left Player |
|---|---|---|---|---|
| Tennis | Green | Yellow | Orange | Magenta |
| Soccer | Blue | Cyan<br>Blue | Cyan<br>Green | Yellow |
| Squash | Brown<br>Cyan | Magenta | Blue | Cyan<br>Green |
| Practice | Green | Green | Yellow | Brown |

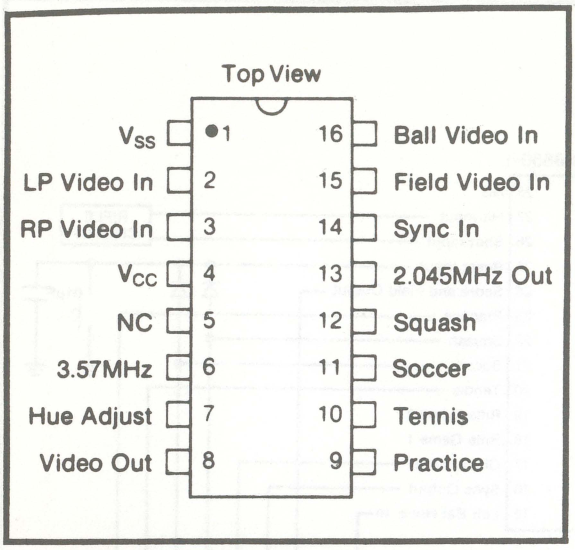



Fig. 5-26. Pin layout of the AY-3-8515-1 color converter chip.

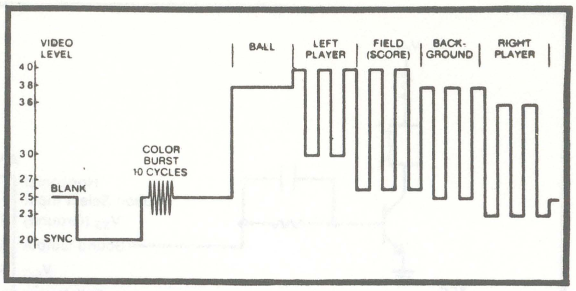



Fig. 5-27. Composite video output signal from pin 8 of the AY-3-8515-1 chip.

Colors may be adjusted for system variations by the chip hue control Fig. 5-28 which varies the phase delay of the color outputs.

For games incorporating rifle, select input 3 may be connected by diodes to the squash select and practice select inputs of the game circuit, and select input 4 may be connected by diodes to the two rifle inputs.

## Luminescence Levels

The luminescence levels of the various signals in the composite video output have been selected to provide black-and-white compatibility. The field and left player signals are set to near-white levels, the right to near-black, and the background is set at a midlevel to show gray. Figure 5-27 shows the typical composite video waveform from the circuit.

In order to assure the correct video levels, a 1K variable potentiometer (connected to pin 8, Fig. 5-28) should be used to adjust the output to a maximum of 4V and a minimum of 2V.

## CLOCK INPUT

The AY-3-8515-1 operated directly from a 3.57 MHz crystal input. A variable capacitor with a range of 3 to 15 pF should be used to tune the crystal.

## CLOCK INPUT

The AY-3-8515-1 generates a low-impedance 2.045 MHz clock to directly drive the game chip without external components.

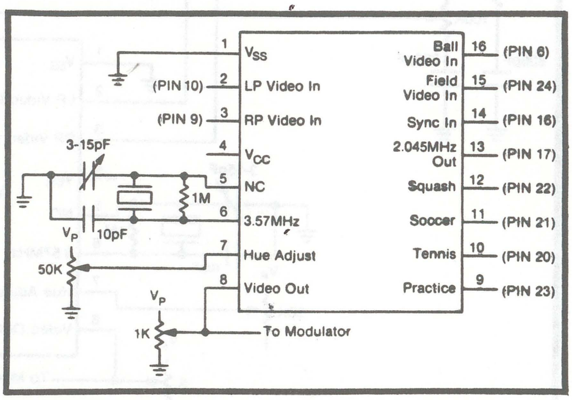



Fig. 5-28. Connection diagram for the AY-3-8515-1 color converter. Pin numbers in parentheses are AY-3-8500-1/8550-1 pins.

# BALL & PADDLE II
# AY-3-8600 & AY-3-8600-1

The AY-3-8600 and AY-3-8600-1 circuits have been designed to provide a TV game function which gives active entertainment using a standard home color or monochrome TV receiver. The circuit is intended to be battery powered and a minimum number of external components are required to complete the system. A schematic diagram of the system is shown in Fig. 5-29.

## CHIP FEATURES

- Full color operation possible
- Eight selectable games

| | |
|---|---|
| Tennis | Practice |
| Hockey | Gridball |
| Soccer | Basketball |
| Squash | Basketball practice |

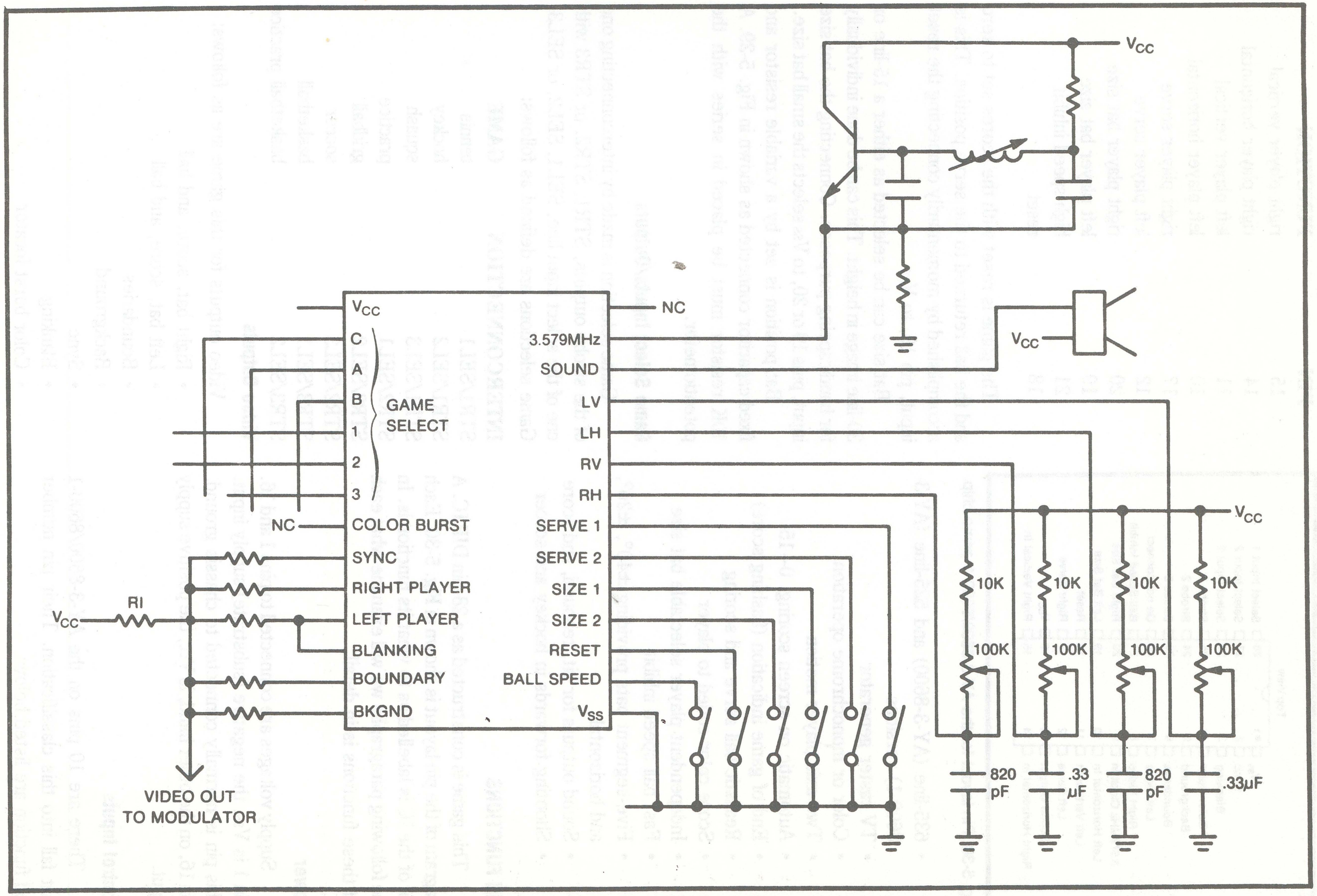



Fig. 5-29. System diagram of the AY-3-8600/8600-1 game chip.

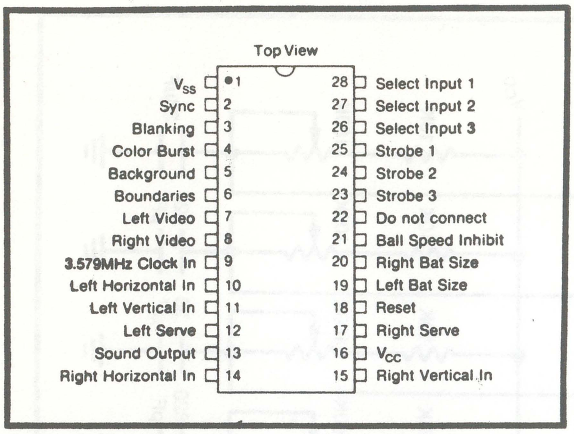



Fig. 5-30. Pin layout for the AY-3-8600/8600-1 game chip.

- 635-line (AY-3-8600) and 525-line (AY-3-8600-1) versions
- TV raster generator
- Color or monochrome operation
- Two-axis player motion
- Automatic on-screen scoring, 0–15
- End of game indication (flashing score)
- Realistic ball serve and scoring
- Score color coded to player
- Independent player selectable bat size
- Fast ball speed inhibit
- Five-segment bats providing ±40°, ±20°, and horizontal
- Sound outputs for hit, rebound, and score
- Shooting forwards in hockey and soccer

## PIN FUNCTIONS

This game is constructed as a 28-pin DIP IC. A diagram of the pin layout is shown in Fig. 5-30. Each pin of the IC is labelled as to what its function is. In the following paragraphs we will examine what each of these functions is in detail.

### Power

Supply voltages are connected to pins 1 and 16. Pin 1 is $V_{SS}$, the negative (substrate) supply input. This pin is normally connected to chassis ground. Pin 16, on the other hand, is $V_{CC}$, the positive supply input.

### Control Inputs

There are 10 pins on the AY-3-8600/8600-1 that fall into this classification. Their pin number and function are listed below:

| PIN | FUNCTION |
|---|---|
| 15 | right player vertical |
| 14 | right player horizontal |
| 11 | left player vertical |
| 10 | left player horizontal |
| 17 | right player serve |
| 12 | left player serve |
| 20 | right player bat size |
| 19 | left player bat size |
| 21 | high speed inhibit |
| 18 | reset |

The game is reset with the scores set to zero and the ball returned to the serve position. This is accomplished by momentarily connecting the reset input, pin 18, to $V_{SS}$.

Bat size can be selected as either a 15-line or 30-line image in height. This can be done individually for handicapping purposes. Connecting the bat size input, pins 19 or 20, to $V_{SS}$ selects the small bat size.

Bat position is set by a variable resistor and fixed capacitor connected as shown in Fig. 5-29. A 10K resistor must be placed in series with the potentiometer.

### Game Select Inputs/Outputs

Game selection is made by interconnecting one of the strobe outputs, STR1, STR2, or STR3 with one of the select input line, SEL1, SEL2, or SEL3. Game selections are defined as follows:

| INTERCONNECTION | GAME |
|---|---|
| STR1/SEL1 | tennis |
| STR1/SEL2 | hockey |
| STR1/SEL3 | squash |
| STR2/SEL1 | practice |
| STR2/SEL2 | gridball |
| STR2/SEL3 | soccer |
| STR3/SEL1 | basketball |
| STR3/SEL2 | basketball practice |

### Video Outputs

Video outputs for this game are as follows:

- Right bat, score, and ball
- Left bat, score, and ball
- Boundaries
- Background
- Sync
- Blanking
- Color burst locator

All signals are present in the circuit to generate a composite video signal with sync, color burst, and blanking. This single video signal provides the input to the game's RF modulator.

Video outputs are provided for each of the two player bats and their scores, the boundaries, background, sync, and blanking. As shown in Fig. 5-29, the ratio of the particular output resistor with resistor R1 sets the luminance level.

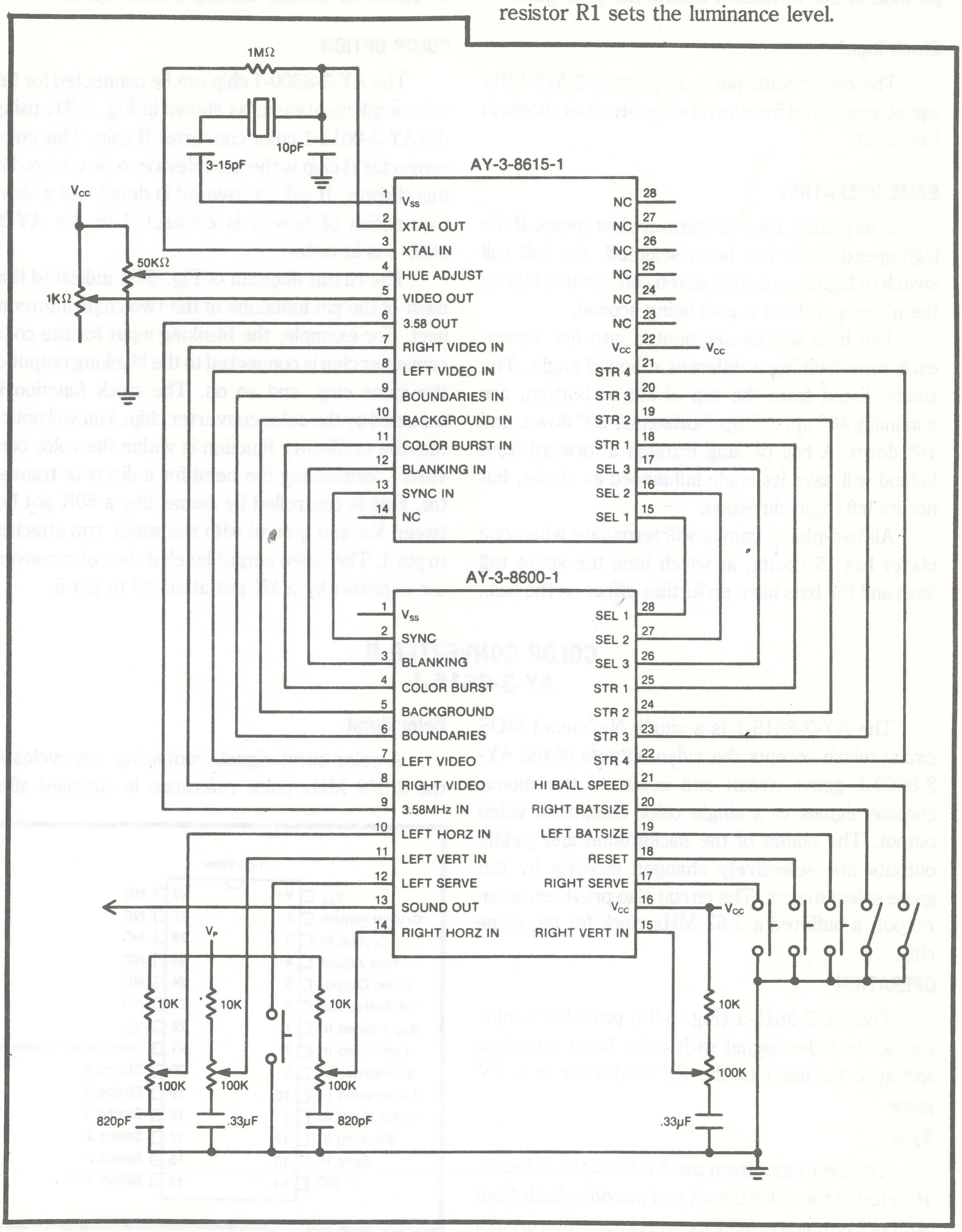



Fig. 5-31. Full color implementation of the AY-3-8600-1 game chip using color converter AY-3-8615-1.

In addition to the above outputs, a color burst locator output is provided for use where external color generation is desired. The signal locates the position in the waveform behind the sync pulse.

### Clock Input

The clock input, pin 9, requires a 3.579 MHz signal, generated from an off-chip circuit as shown in Fig. 5-29.

### GAME OPERATION

In all games, the ball starts at slow speed. If the high-speed mode has been selected, the ball will switch to high speed after seven consecutive hits by the players without a goal being scored.

The bats will be segmented into five zones, each zone defining a different rebound angle. The zones, listed from the top of bat to bottom, are nominally 40° up, 20° up, horizontal, 20° down, and 40° down. A ball passing through a forward from behind will have its angle influenced as above, but not its left/right direction.

All two-player games will terminate when one player has 15 points, at which time the score will flash and the bats have no further effect on the ball.

Tone of approximately 500 Hz, 1 kHz, and 2 kHz will be outputted for a nominal period of 32 ms for ball-wall hits, ball-bat hits, and score. The output is capable of directly driving a 100Ω speaker.

### COLOR OPTION

The AY-3-8600-1 chip can be connected for full color implementation, as shown in Fig. 5-31, using the AY-3-8615-1 color converter II chip. This color converter II chip is the next device to be covered in this chapter. It will be covered in detail, but a short explanation of how it is connected to the AY-3-8600-1 is in order.

The circuit diagram of Fig. 5-31 indicated that most of the pin functions of the two chips interconnect. For example, the blanking input for the color converter chip is connected to the blanking output of the game chip, and so on. The clock function is assumed by the color converter chip. You will notice that the oscillatory function is within the color converter, eliminating the need for a discrete transistor. Hue is controlled by connecting a 50K pot between $V_{CC}$ and ground with the wiper arm attached to pin 4. The video output level of the color converter is preset by a 1K pot attached to pin 5.

## COLOR CONVERTER II
## AY-3-8615-1

The AY-3-8615-1 is a single N-channel MOS circuit which accepts the video outputs of the AY-3-8600-1 game circuit and converts the monochrome signals to a single color composite video output. The colors of the background and paddle outputs are selectively changed directly by the game select matrix. The circuit also provides, as an output, a buffered a 3.57 MHz clock for the game chip.

### OPERATION

The AY-3-8615-1 (Fig. 5-32) provides a color composite video signal with color burst envelope and sync for input to the RF modulator of a TV game.

### Sync

The sync input from the AY-3-8600-1 is reconstructed in the color circuit and provides both front and back porches to insure correct operation in color TV circuits.

### Color Burst

A color burst signal, containing ten cycles of the 3.579 MHz color reference is supplied after

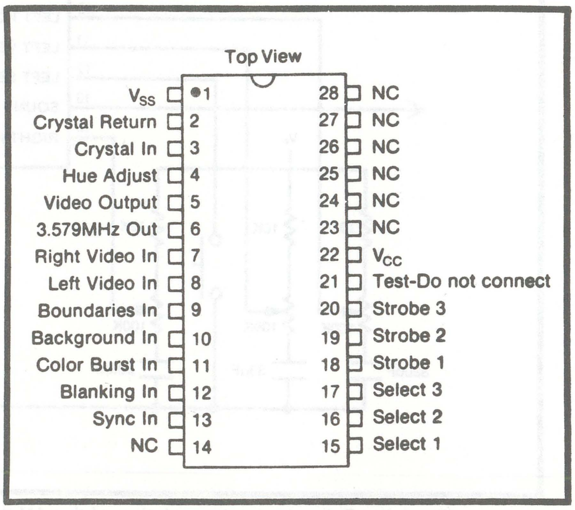


Fig. 5-32. Pin layout of the AY-3-8615-1 color converter.

sync. The color phase of the burst is internally shifted by the game matrix inputs with respect to the phases of the background, right player, and left player so that different colors may be rendered for each game. This color change may be affected with no external components. The color burst is followed by an appropriate blanking interval so the TV set will not lock on to the background phase.

### Video Inputs

Six video inputs are provided on the AY-3-8615-1. These are: field, background, color burst locator, left player, right player, and blanking.

### Video Output

After sync, color burst, and blanking, the video consists of background, field, scores, right player, left player, and ball.

Colors may be adjusted for system variations by the chip hue control, which varies the phase delay of the color outputs.

### Luminescence Levels

The luminescence levels of the various signals in the composite video output have been selected to provide monochrome compatibility. The field and left player signals are set to near-white levels, the right to near-black level, and the background is set at a midlevel to show gray.

Figure 5-33 shows the typical composite video waveform from the circuit.

In order to assure the correct video levels, a 1K variable potentiometer should be used to adjust the output to a maximum of 4V and a minimum of 2V.

### CLOCK INPUT

The AY-3-8615-1 is operated directly from a 3.579 MHz crystal input. A variable capacitor with a range of 3 to 15 pF should be used to tune the crystal.

### CLOCK OUTPUT

The AY-3-8615-1 generates a low-impedance 3.579 MHz clock to directly drive the game chip without external components.

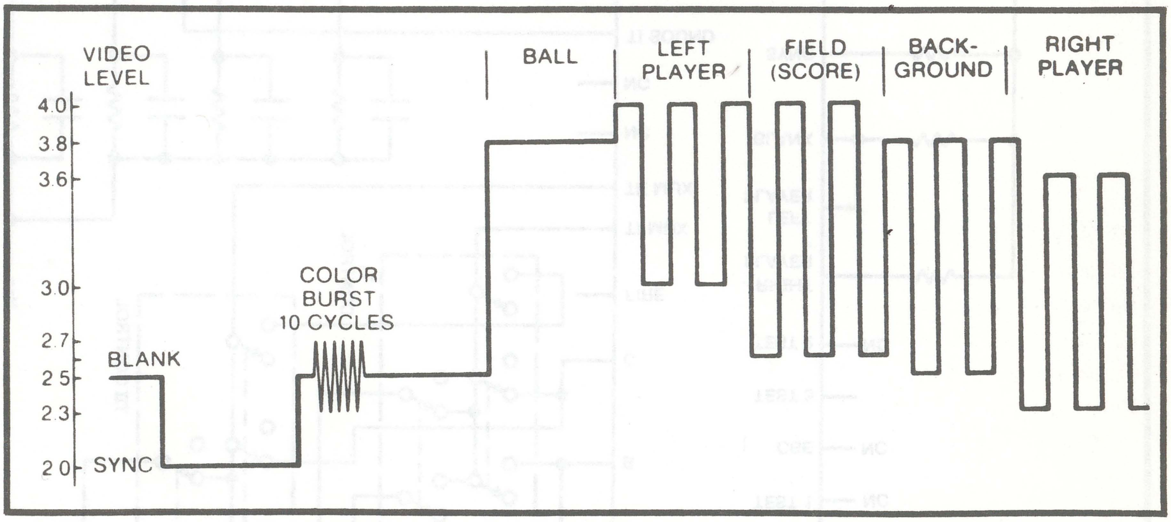



Fig. 5-33. Composite video output from pin 5 of the AY-3-8615-1 color converter.

## BATTLE I
## AY-3-8700 & AY-3-8700-1

The AY-3-8700/8700-1 circuit (Fig. 5-34) is a tank battle game and has been designed for two players, where each player has a completely steerable tank with forward and reverse speed control and a firing button. Antitank barricades and mines are in the battlefield to retard each tank's progress while under battle conditions. The object of the game is to score as many hits on the enemy tank as possible. The first player to reach 31 hits ends the game. The circuit is designed to be used with standard domes-

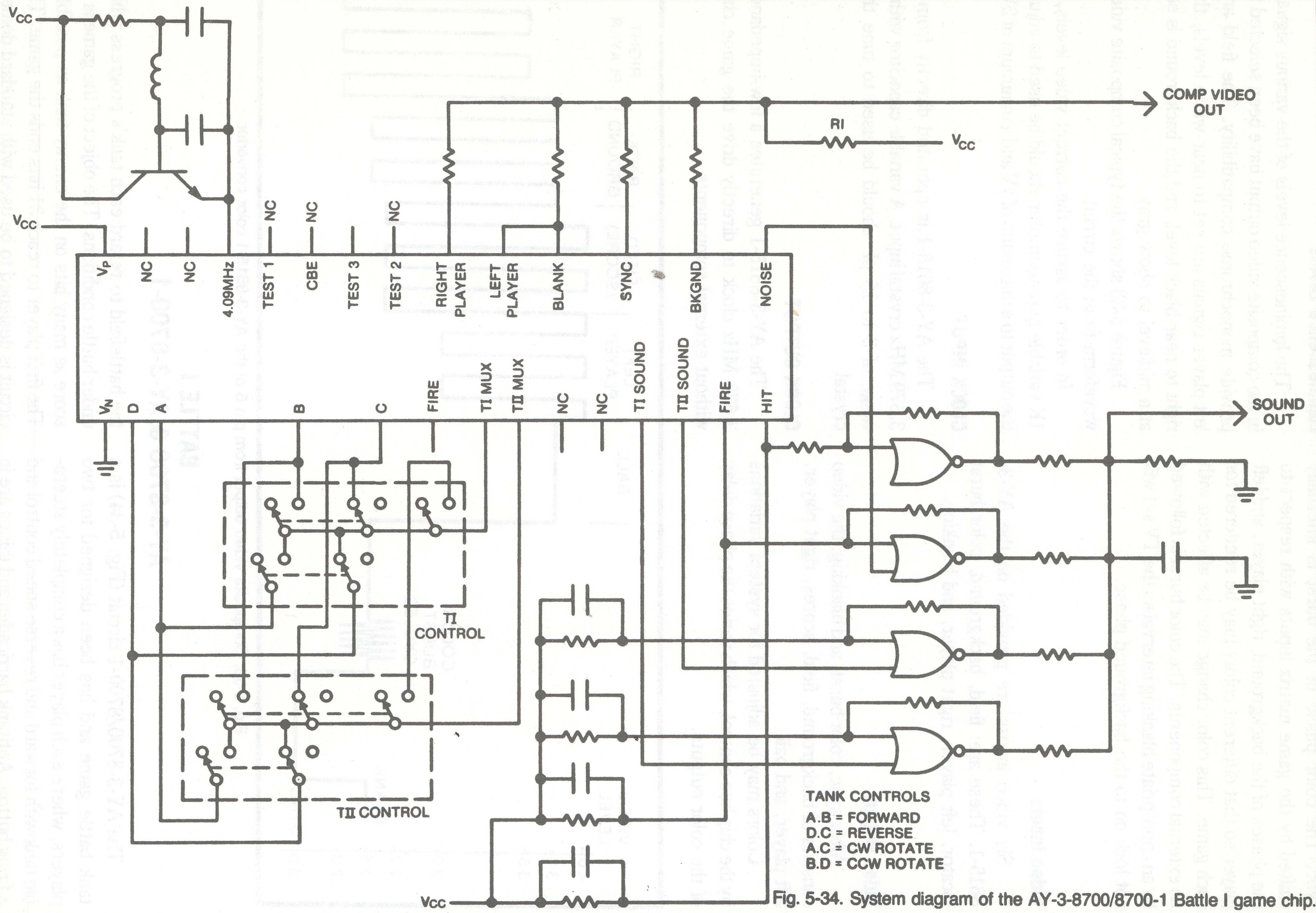



Fig. 5-34. System diagram of the AY-3-8700/8700-1 Battle I game chip.

tic television receivers. The AY-3-8700/8700-1 is manufactured in a 28-pin DIP (Fig. 5-35) and can be used in battery systems with a minimum number of components to provide a complete game.

## FEATURES

- Two independently controllable tanks
- Tank explosion and sounds when hit by shell or mine
- Exploding mines
- Shell firing and burst video and sound
- Three forward and reverse tank speeds
- 32 rotational angles
- Fixed terrain barriers
- Realistic tank sounds
- Automatic on-screen scoring
- Scores color keyed to player
- 625-line (AY-3-8700) and 525-line (AY-3-8700-1) versions

## VIDEO SIGNAL OUTPUT

All signals are present in the circuit to generate a composite video signal with a waveform which includes composite blanking and color burst envelope. This simple video signal provides the input to the game RF modulator.

The luminance levels are set by the ratios of the resistors shown in the system diagram of Fig. 5-34. This output configuration provides maximum flexibility to the user who can set, at his option, either a positive or negative sync.

Five outputs are provided: sync, right player, left player, background, and blanking. The right player output includes the tank symbol, right player score, shells fired by the right tank, shell burst from right tank shells, and mines. The left player output includes the left tank, left player score, shells fired by the left tank, left tank shell bursts and fixed barriers.

It is recommended that one tank be displayed in white, one in black, and the background in gray.

The blanking and black (left player) outputs are shown connected to a single resistor since the modulation level is approximately the same for both.

In addition to the preceding five outputs, a color burst locator is provided to enable users who wish to provide a color background to locate the color burst envelope at the correct waveform position after the sync output.

## TANK DISPLAYS

The tanks are controlled by connecting the appropriate strobe outputs to the track inputs. Forward motion is achieved when both the right and left track forward inputs are connected to the strobe. On connection, the tank will advance in low speed. If the connection is held, the medium speed will select after a half-second. After another 1 second of connection, high speed is selected. Breaking the connection when any speed is achieved will cause the tank to remain at the selected speed. The controls should each be single-pole-double-throw (SPDT) center off momentary switches.

The tank can be made to go through the three reverse speeds at 1-second intervals by connection of the left and right reverse track inputs to the appropriate strobe output. Tank rotation in a clockwise (right turn) direction is caused by connection of the left forward and right reverse track inputs to the strobe, while counterclockwise (left turn) direction is caused by connection of the left forward and right reverse track inputs to the strobe. The tanks are able to turn while either in forward or reverse speed and rotate when stationary. See Fig. 5-36 for a screen display of Battle I.

### Tank Details

| | |
|---|---|
| Definition and resolution | 64 bits (8×8) or 8/100 of TV screen width |
| Orientations | 32 |
| Direction of travel and firing angles | 32 |
| Forward speeds | 3 |
| Reverse speeds | 3 |

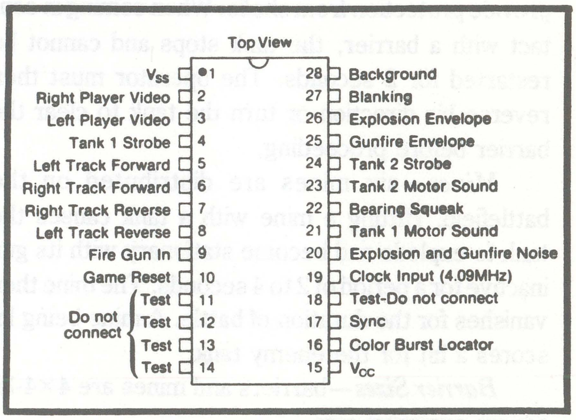



Fig. 5-35. Pin layout of the AY-3-8700/8700-1 game chip.

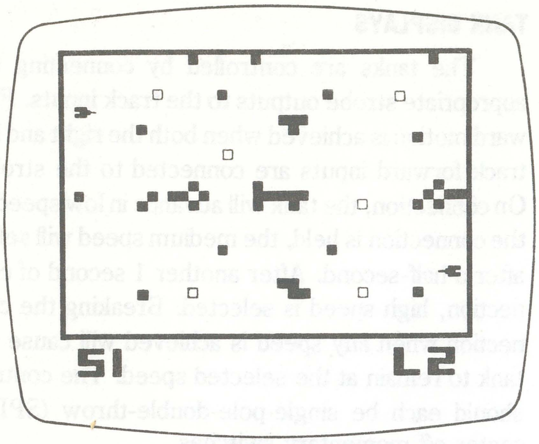


Fig. 5-36. Typical Battle I display.

## SHELL DISPLAY

Connection of the gun fire input to a strobe output with an SPST normally open pushbutton switch causes the firing of a tank gun and release of a projectile. The firing rate is approximately once every 4 seconds and the refire requires release of the button and redepression. Depressions made during the 4-second interfiring time are ignored by the circuit.

When a shell is in flight, the rotation of the tank will cause the shell to follow a curved trajectory in the direction of tank rotation. The range of a shell is approximately two-thirds of the screen length or width depending on the firing angle. The shell is a 2×2-bit dot.

## BATTLEFIELD BARRIER DISPLAYS

*Fixed Terrain Barriers*—a minimum of twelve pseudorandom fixed terrain barriers are on the battlefield to both impede the progress of the tanks and provide protection from shells. When coming in contact with a barrier, the tank stops and cannot be restarted for 2 seconds. The operator must then reverse his direction or turn the tank to clear the barrier before proceeding.

*Mines*—six mines are distributed on the battlefield. Hitting a mine with a tank causes the tank to explode and become stationary with its gun inactive for a period of 2 to 4 seconds. The mine then vanishes for the duration of battle. A mine being hit scores a hit for the enemy tank.

*Barrier Sizes*—barriers and mines are 4×4-bit square minimum size.

## VIDEO EXPLOSIONS

*Shell Bursts*—shell burst patterns are produced when a shell is at end of range or when the shell makes contact with a barrier.

*Tank Explosions*—a tank will explode and fragment when a tank hits a mine or is struck by a shell.

## SCORING

Separate scores, color coded to the tank, are indicated for each player. A player's score is incremented when his tank scores a hit on his opponent's tank or the opponent's tank hits a mine. The game ends when either player scores 31 points.

## RESET

The game is reset by momentarily connecting the reset input to ground through an SPST pushbutton. On reset, the scores are cleared to zero, mines replaced, and the tanks reset to the upper-left and lower-right corners in the stationary condition.

## SOUND OUTPUT

The sound outputs produced by the circuit are low frequency, typical of those associated with heavy-equipment motors and explosions. It is recommended that the sound be reproduced through the TV set or in a large speaker so the full richness of the sound can add the proper atmosphere to the game.

## ENGINE SOUND

Outputs are provided for the engine sound associated with each tank. Four motor frequencies are provided: one for each of the three speed ranges and one for stationary condition. A typical sound circuit for filtering each output is shown in the system diagram of Fig. 5-34.

## GUN FIRE SOUND

Gun fire sounds are produced by mixing the noise output with the fire output. The fire output should be filtered and mixed with the noise output as shown in Fig. 5-34.

## SHELL BURST & TANK EXPLOSION SOUNDS

Shell burst sounds are produced when a shell reaches the end of its range or hits a barrier. Tank

explosion sounds are produced when a tank hits a mine or is struck by a shell. These sounds are generated by filtering the hit output which is an open-drain FET to $V_N$, then using the filtered output to gate the noise output. A typical circuit is shown in the system diagram.

## GIMINI PROGRAMMABLE GAME SET

The GIMINI cassette programmable game set is a multichip set which can accept different program chips programmed by the user to provide an unlimited number of games including aggression games, ball and paddle games, gambling games, racing games, etc. The set consists of a CP1610 microprocessor, 20K ROM game program chips, a standard television interface chip, and a 16K ROM graphics storage chip. In addition, the user will have to provide five 256×4-bit RAM circuits.

The games can accept up to eight player inputs, and the set is designed for operation in color or monochrome with standard domestic television receivers.

### FEATURES

- User game design capability.
- Up to eight player operation.
- Up to eight moving screen objects controlled by user.
- 64 selectable moving objects.
- Up to 240 selectable background objects.
- 64 text symbols.
- Movable background field.
- Six colors plus black and white.

### CP1610 MICROPROCESSOR

The CP1610 is a variant of the General Instrument CP1600 microprocessor and is designed for game operation. The chip is a 16-bit IC utilizing eight general purpose registers for fast and efficient processing of all game data. The processor operates only when picture data is not being presented and controls the addresses in both the program 20K ROM and the scratchpad memory according to the game rules.

### 20K ROM RO-3-20480

The program ROM is organized as 2048×10-bit unit and contains all game rules. Because the set is organized on a data bus principle, additional ROM for more complex games may be added, or ROM may be interchanged to provide a user selectable game format. The unit also stores all symbol locations, color velocity, and direction data.

### RAM

Up to five (5) 256 × 4-bit RAMs are required in the system. These are standard units with a 320 ms (nanosecond) access time.

### AY-3-8900/8900-1 STIC

The STIC (standard television interface chip) provides the video signals including sync and blanking in a noninterlaced pattern for the TV, deriving its output from graphics data specified by the microprocessor and obtained from the graphics ROM. The unit is functional only during picture time and obtains new graphics data between picture lines. The video output will consist of the six colors, black, white, sync, blanking, and color burst. In addition, the STIC will provide an audio output signal for most game sounds.

### RO-3-9316A GRAPHICS ROM

The 16K graphics ROM will contain a series 8 × 8-dot matrices for a large variety of game symbols, composite background sections to complete field outlines, and 64 alphanumeric characters. Special graphic symbols may be specified by the user for inclusion in custom processors.

### SYSTEM DESCRIPTION

The GIMINI programmable game set consists of three major subsystems (refer to the system block diagram in Fig. 5-37):

1. The host processor consisting of:
   - (a) CPU (CP1610)
   - (b) System instruction ROM (RO-3-20480).
2. Random access memory consisting of:
   - (a) 256–12-bit words.
   - (b) 256–8-bit words.
3. The graphics processor consisting of:
   - (a) STIC, standard television interface chip (AY-3-8900/8900-1)
   - (b) Graphics ROM (RO-3-9316A)

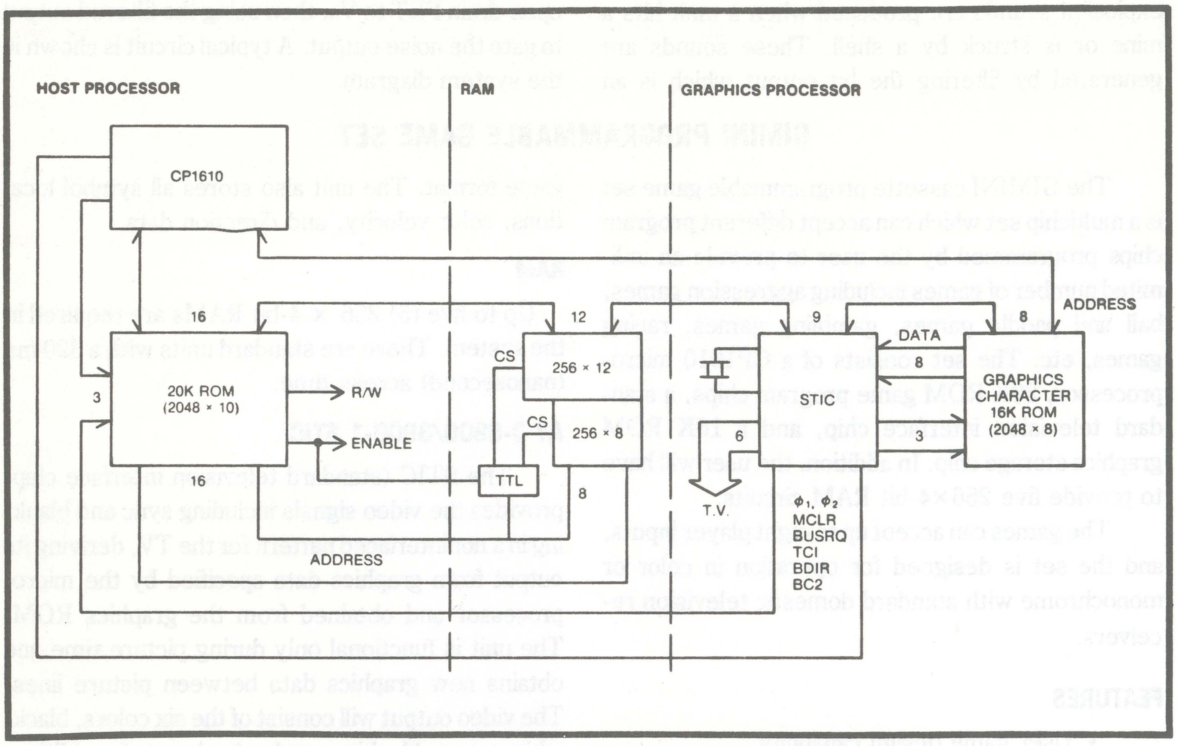



Fig. 5-37. System diagram for the GIMINI programmable game set.

The host processor, via the system instruction ROM, executes a fixed program using a specific area of RAM for variables and a second area for graphics instructions. The graphics instruction area is common to the graphics processor.

The graphics processor, using the common RAM area, fetches data from RAM, decodes, fetches from the graphics ROM the picture to be displayed, and displays it on the screen at the required position.

During the drawn picture time any interactions of shapes are recorded. Then, at the end of the picture time, they are made available to the host processor for decoding of the picture status.

For the system to operate, each 1/60 second is divided into five time slots which relate closely to the timing and synchronizing of the TV.

*Time Slot 1*—A time slightly greater than the TV frame blanking; approximately 4.5 ms is dedicated to host processor. This time can be increased by the host processor on a frame stealing basis.

*Time Slot 2*—Active picture time consisting of 45 $\mu$s of each 63.5 $\mu$s line for 192 lines.

*Time Slot 3*—A time slightly greater than the line-blanking time, 17.8 $\mu$s, which is used by the graphics processor for processing the moving object data.

*Time Slot 4*—Consisting of the last two lines before the active picture when the graphics processor fetches the instructions from RAM of all the next-moving-object data into its internal scratchpad area.

*Time Slot 5*—The first two lines after the active picture when the interaction data and the picture status are available for the host processor.

## TYPICAL OPERATION

1. System on.
2. Current game library displayed. (Automatic switch on routine, ROM programmed.)
3. User presses select input. (Host processor seeking external branch.)
4. If game has subset selection, i.e., 1-, 2-, 3-, or 4-player modes, a new library displayed.
5. The host processor computes the start-game-picture instructions and writes to common RAM; it also computes the start condition of variables involved in the strategy of the game or motion constants. This setup could, in some games, take several picture frames. Therefore, the TV picture is presented as a single color wash. (This may be

substituted with a kaleidoscope effect if the time for setup is more than 1 second.)

6. When the host processor gives control to the graphics processor, the first TV picture will be drawn using the following sequence of events. The first two lines before the active picture, up to forty 8-bit words will be fetched. This includes the following data:

(a) the individual *x* and *y* coordinates of the top left-hand corner of eight moving objects, their location in the graphics library, color, visibility, and orientation (facing, left, right, up ana down).

(b) border color.

(c) background color.

(d) background offset in *x*, *y* from the top left-hand corner of the active picture.

7. At the end of the last two lines before the active picture, the first eight horizontal points of each of the eight moving objects will be fetched from the graphics ROM and loaded into the scratchpad in the graphics processor.

8. The graphics processor will then begin the active picture subroutine. At this time, beginning at address 000 in the 12-bit RAM area, each RAM address is fetched in sequence (20 per line). (Each address contains a secondary address for the graphics ROM plus an instruction on how to use the data contained in that address). Each 20 consecutive RAM locations are re-addressed on 16 lines in each picture frame. This results in the picture requiring only 240 words to describe the entire screen (in RAM) while using the graphics ROM to detail the point-by-point detail in any one of the 240 background card locations.

9. At the end of each active picture line the next (if required) picture dots of the moving objects are fetched from ROM and loaded to the graphics processor scratch pad.

10. Cards and moving objects are outputted simultaneously by the graphics processor. If, however, there is a conflict, moving objects have priority write. This feature is the basis of interaction recording, i.e., object coincidence indicates an interaction to be decoded by the host processor.

11. By the end of the picture, all interaction possibilities would have been recorded. The graphics instruction detector can record all of the 67,108,869 possible moving object interactions. Additionally, there are 16,384 ways the moving objects can interact with the background objects. These are also recorded. The interaction structure is such that either shape, color, vertical position, horizontal position, or right-angle position interaction can be detected and acted upon.

12. The host processor regains control at the end of the active picture and computes the outcome of the last action and what new action is required due to the picture interactions and change in the user controls.

## AVAILABLE GAMES

- Black jack
- Draw poker
- Acey/deucy
- War
- Combat squares
- Racing squares
- Shooting squares
- Jungle I
- Jungle II
- Volleyball
- Protection
- Hazard
- Roadrace
- Barricade
- Submarine
- Dogfight

# CHAPTER 6

# TEXAS INSTRUMENTS GAME CHIPS

Technical information in this section is by courtesy of Texas Instruments, Inc.

At this time Texas Instruments does not build a complete TV video game. They do design and manufacture the game chips that many game makers use in their own products. Thus, you can use the information in this section to service many brands of video games that use TI chips. All you need do is look at the TI chip number in the game and find the same number in this section for IC information. You will also find some typical TV video game application schematics in this section.

## SN76410N VIDEO GAME CHIP

Features of Game

- Super spin or automatic random english.
- Six games:
  - Tennis
  - Catch
  - Practice catch
  - Team pitch
  - 1-player pitch
  - Handball
- Automatic interval scoring.
- Sound output.
- Solid rebound walls, dashed tennis net.
- NTSC compatible video.
- Power required - 6V DC.

### Description of Chip

The SN76410 IC uses $I^2L$ technology for the following advantages:

- Allows system with less than 35 components.
- Eliminates crystal requirements.
- Provides low power consumption.
- Integrates the RF modulator.

This game IC accepts two potentiometer voltages to control the player's vertical position. The circuits keep score, process game logic, generate sync pulses, and produce an NTSC compatible video signal, RF modulated, that is fed directly into the TV set's antenna. The block diagram for this IC is shown in Fig. 6-1. Pin assignment for SN76410N is found in Fig. 6-2.

Shown in Fig. 6-3 is a typical applications schematic for the SN76410 IC super spin system.

Approximate timing pulses for this game chip are shown in Figs. 6-4 and 6-5.

## SN76499N COLOR CONVERTER CHIP

The SN76499N IC utilizes low-power Schottky TTL technology to convert up to five individual monochrome video signals into a single summed color composite video signal. The output video signal may then be modulated and fed to a TV receiver. The IC can be used in any system for which there is

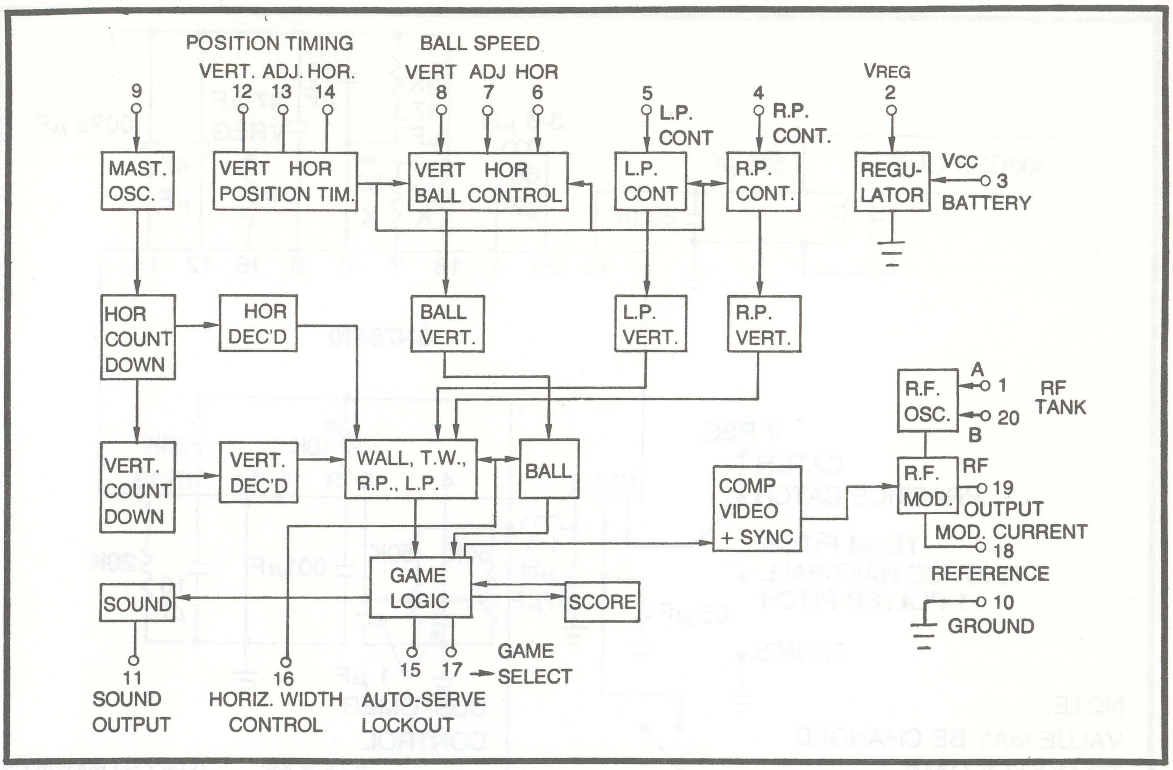



Fig. 6-1. Block diagram of the SN76410N IC.

a need to convert B & W video signals to a color composite video signal. Refer to Fig. 6-6 for chip block diagram.

## COLOR CONVERTER IC OPERATION

The SN76499N IC is compatible with TTL and CMOS chips. The IC contains a video summer which will accept video information on pins 16, 17, 18, 19 and 20. A composite video waveform is generated containing horizontal and vertical blanking, horizontal and vertical sync color burst, background video information, spot information (players, walls, balls, score, etc.), and serration pulses.

Color burst begins at the end of horizontal sync and continues for 8 to 14 cycles (number of cycles dependent on burst delay adjust at pin 8) of the color subcarrier, 3.58 MHz. The color yellow (nominal) is assigned to any informafion fed to video input pins 16 and 17. The color phase is the same as burst. The light-blue color (nominal) is assigned to any information fed to video input pins 19 and 20.

Background color is adjustable by raising or lowering the DC level into pin 3, with an adjustment

PIN ASSIGNMENT

| | |
|---|---|
| 1 - RF TANK A | 12 - VERTICAL TIMING RAMP |
| 2 - VREG OUTPUT | 13 - RAMP ADJUST |
| 3 - VCC - BATTERY INPUT | 14 - HORIZONTAL TIMING RAMP |
| 4 - RIGHT PLAYER CONTROL | 15 - AUTOMATIC SERVE LOCK-OUT TIMING |
| 5 - LEFT PLAYER CONTROL | 16 - HORIZONTAL WIDTH CONTROL |
| 6 - BALL SPEED HORIZONTAL CONTROL | 17 - GAME SELECT - TRI-STATE INPUT |
| 7 - BALL SPEED ADJUST | 18 - MODULATOR CURRENT REFERENCE |
| 8 - BALL SPEED VERTICAL CONTROL | 19 - RF MODULATED OUTPUT |
| 10 - GROUND | 20 - RF TANK B |
| 11 - SOUND OUTPUT (OPEN COLLECTOR) | |

Fig. 6-2. Pin assignment for the SN76410N IC.

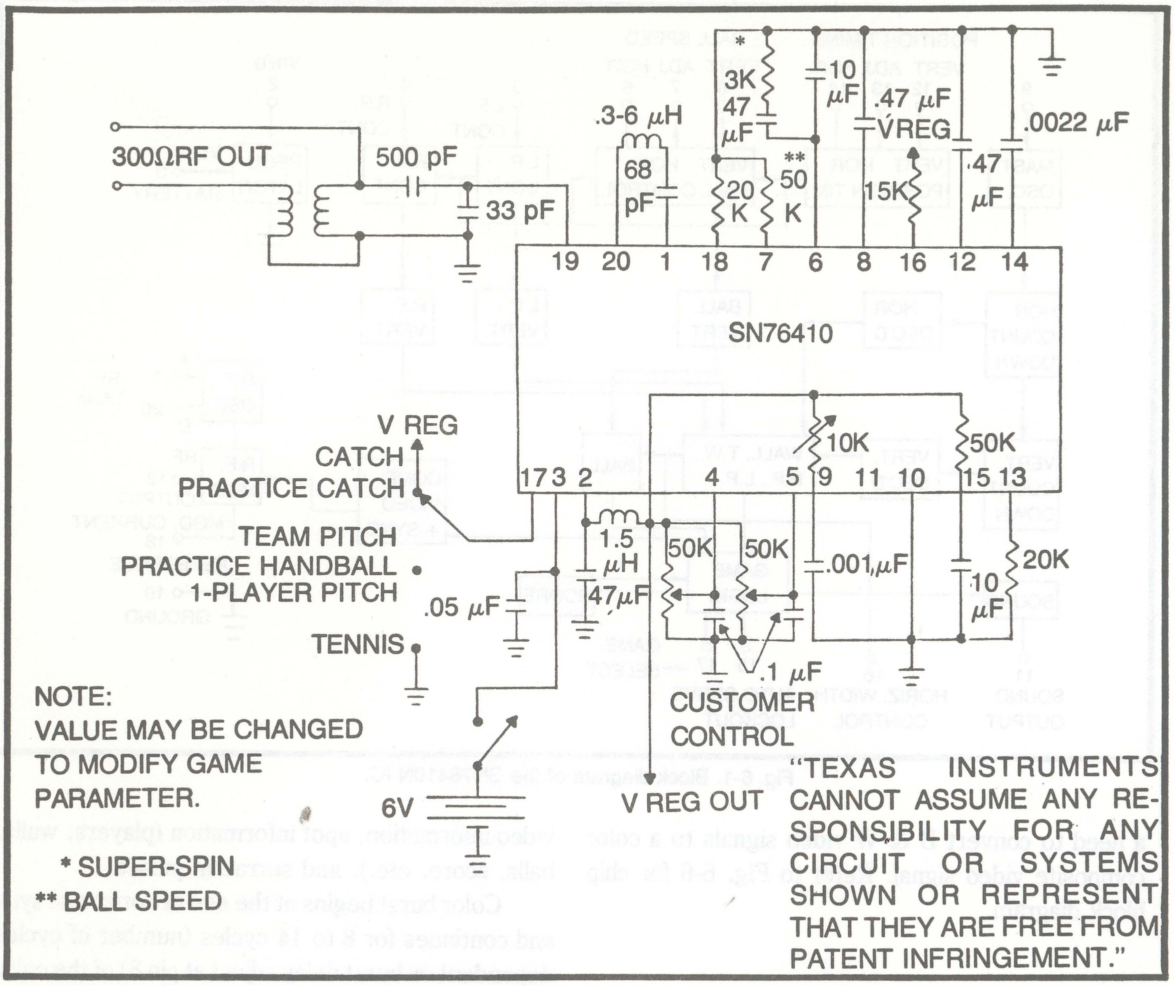



Fig. 6-3. Applications schematic for the SN76410N chip.

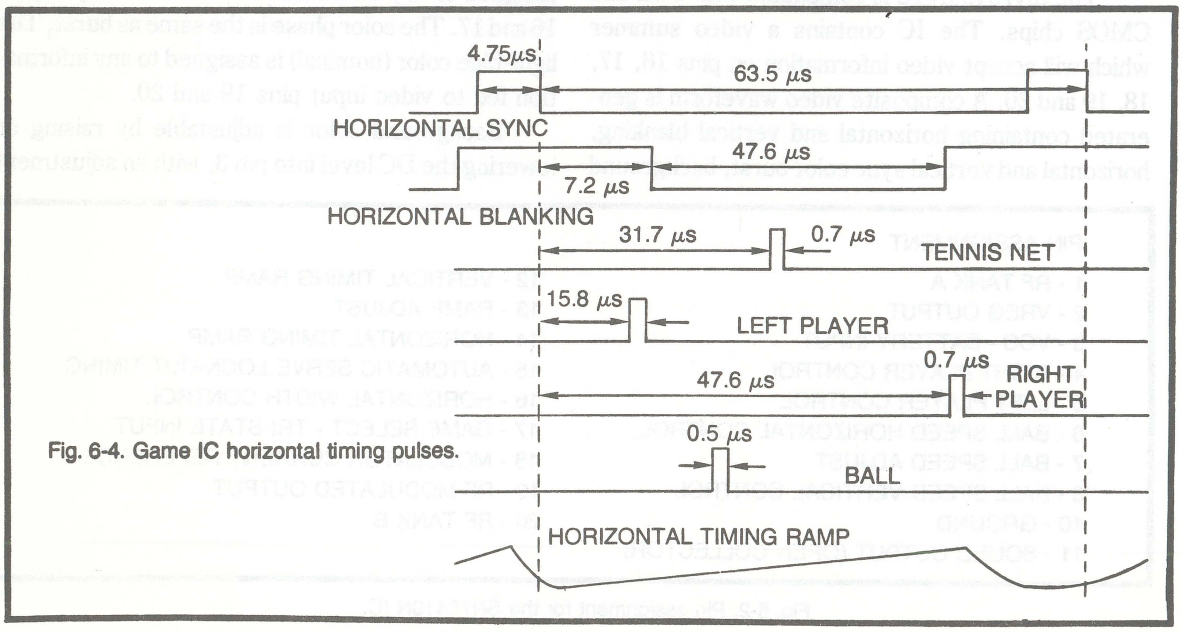



Fig. 6-4. Game IC horizontal timing pulses.

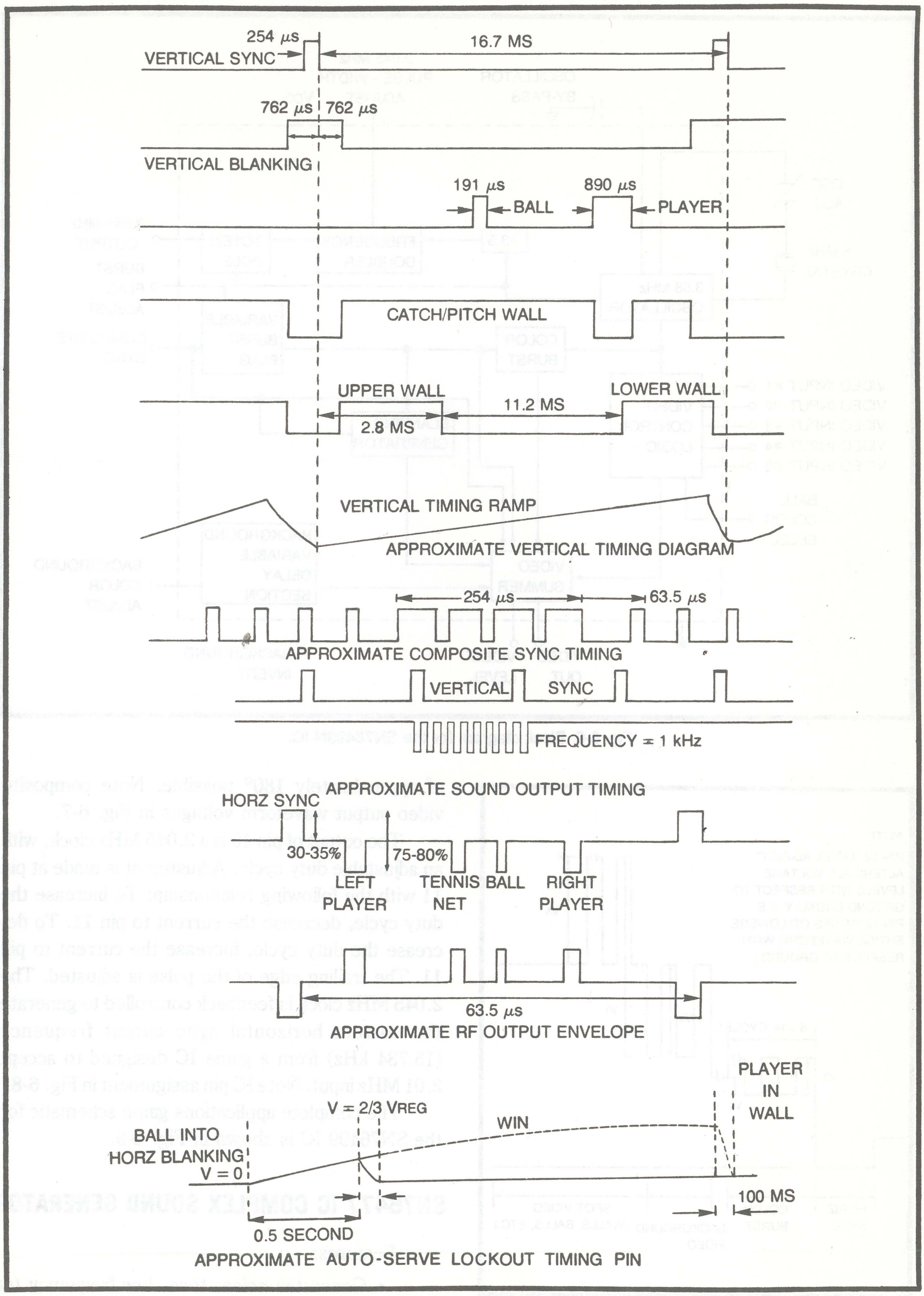



Fig. 6-5. Game IC timing pulses.

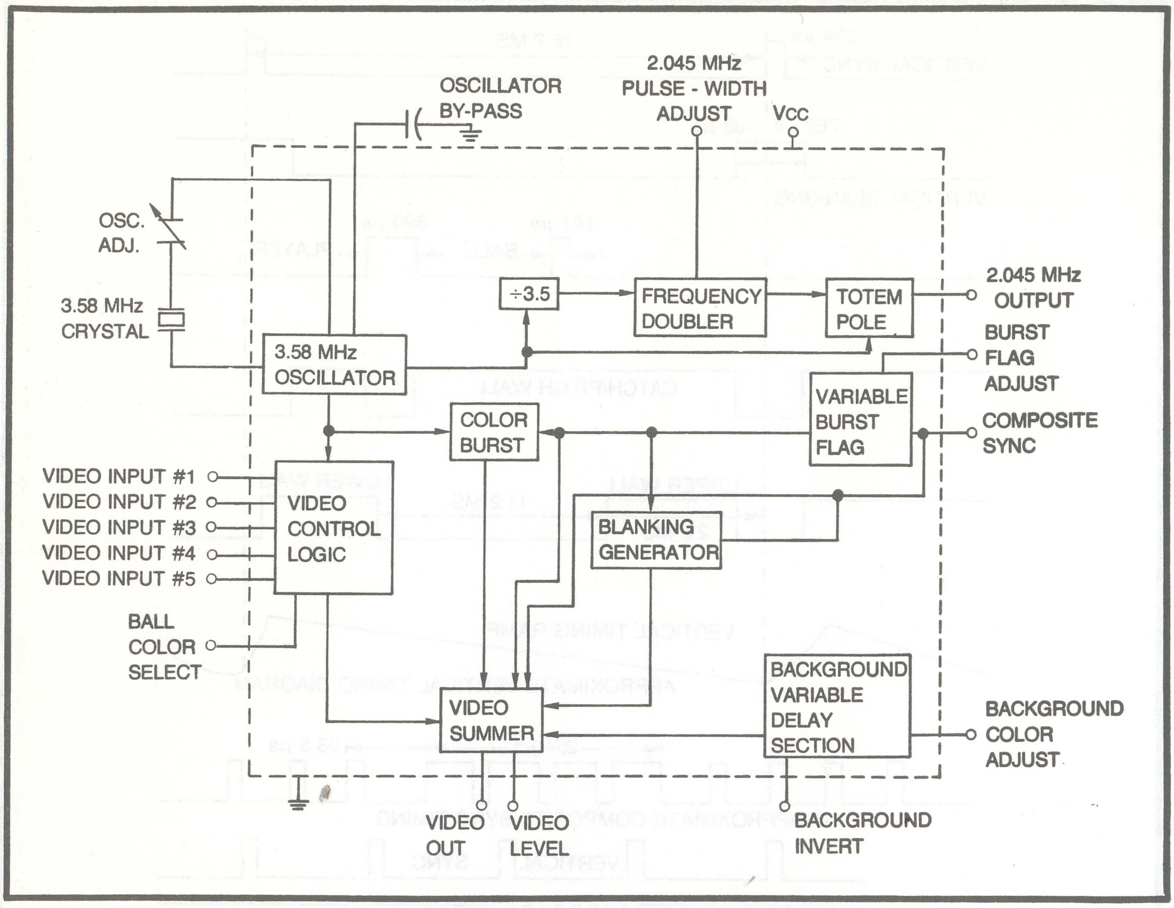



Fig. 6-6. Block diagram for the SN76499N IC.

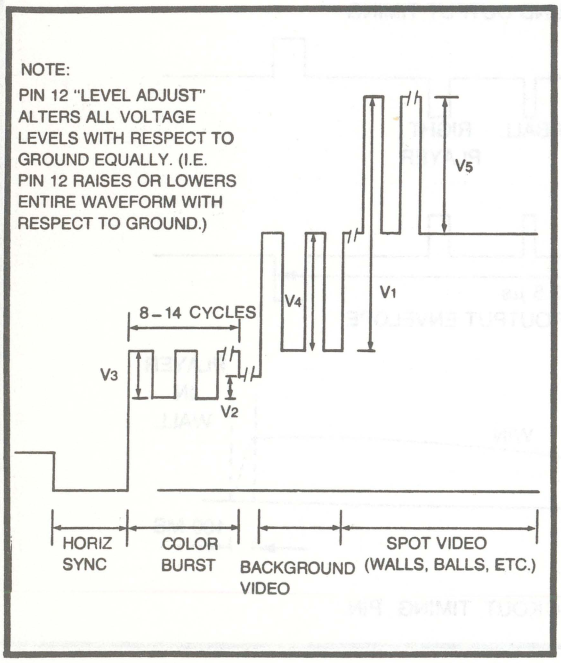



Fig. 6-7. Composite video output waveform.

of approximately 180° possible. Note composite video output waveform voltages in Fig. 6-7.

The output of pin 10 is a 2.045 MHz clock, with an adjustable duty cycle. Adjustment is made at pin 11 with the following relationship: To increase the duty cycle, decrease the current to pin 11. To decrease the duty cycle, increase the current to pin 11. The trailing edge of the pulse is adjusted. The 2.045 MHz clock is feedback controlled to generate the correct horizontal sync output frequency (15.734 kHz) from a game IC designed to accept 2.01 MHz input. Note IC pin assignment in Fig. 6-8.

The complete applications game schematic for the SN76499 IC is shown in Fig. 6-9.

## SN76477 IC COMPLEX SOUND GENERATOR

Features:

- Generates noise, tone, low-frequency (or mixture) based sounds.

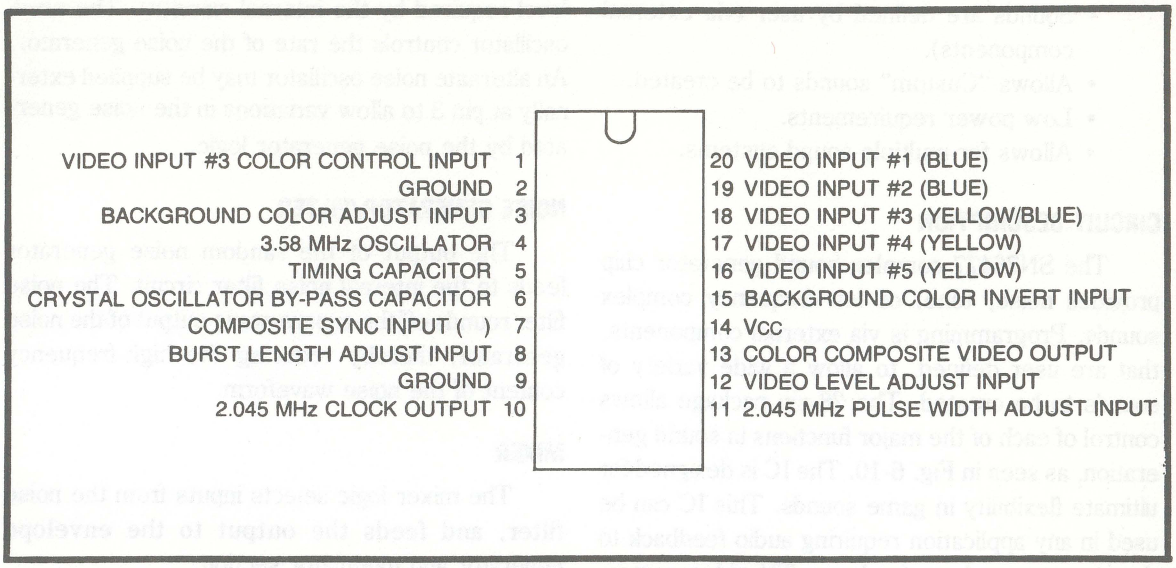



**Fig. 6-8. Pin assignment for SN76499N IC.**

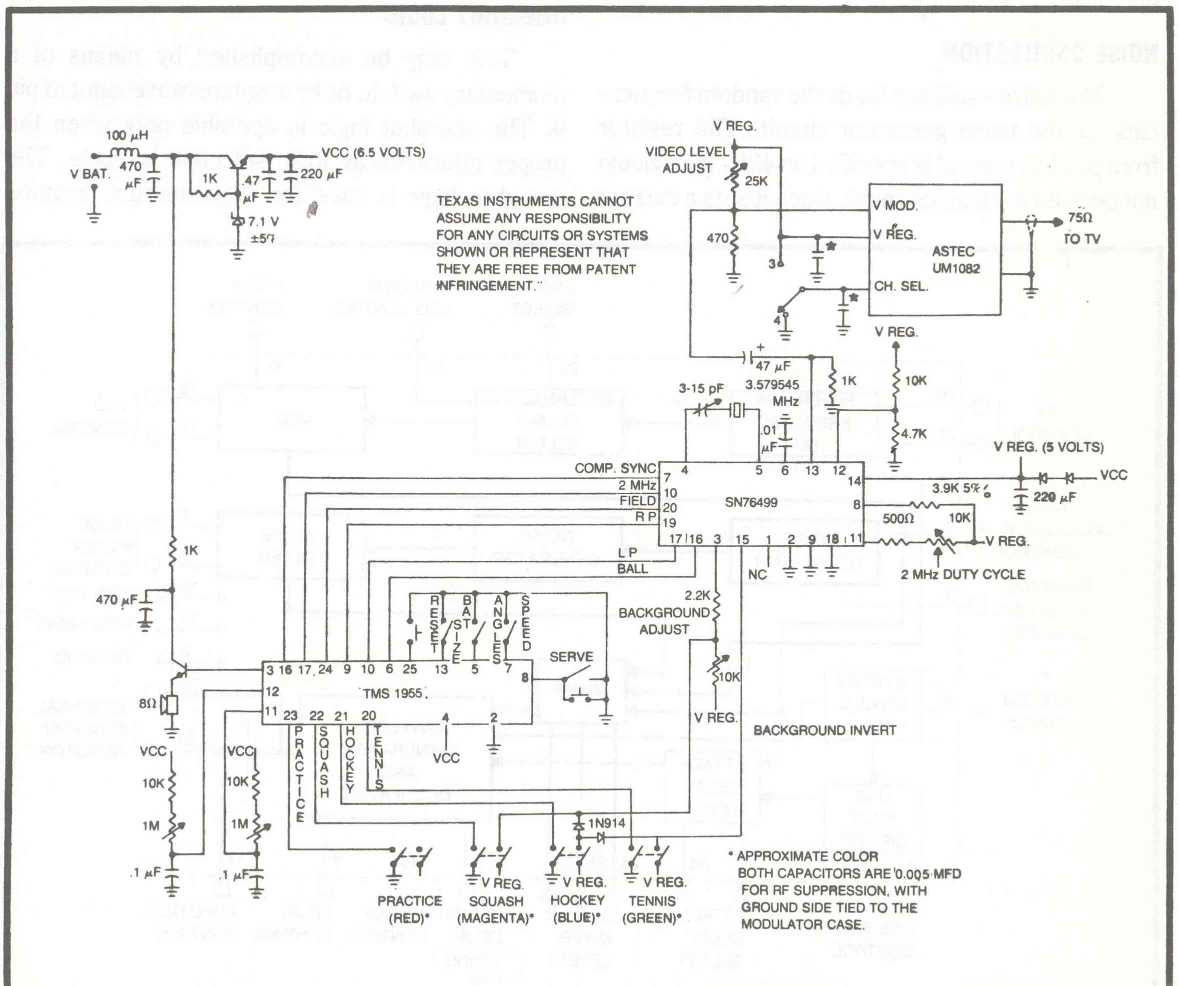



**Fig. 6-9. Application schematic for the SN76499N IC.**

- Sounds are defined by user (via external components).
- Allows "Custom" sounds to be created.
- Low power requirements.
- Allows for multiple-sound systems.

## CIRCUIT DESCRIPTION

The SN76477 complex sound generator chip provides noise, tone, or low-frequency complex sounds. Programming is via external components, that are user defined, to allow a wide variety of sounds to be created. The 28-pin package allows control of each of the major functions in sound generation, as seen in Fig. 6-10. The IC is designed for ultimate flexibility in game sounds. This IC can be used in any application requiring audio feedback to the operator such as for home TV video games, pinball games, and toys.

## NOISE OSCILLATION

The noise oscillator feeds the random frequencies for the noise generator circuit. The resistor from pin 4 to ground is specified as 43K, and should not be used as an adjustment, since it sets a current level required by the internal circuitry. The noise oscillator controls the rate of the noise generator. An alternate noise oscillator may be supplied externally at pin 3 to allow variations in the noise generated by the noise generator logic.

## NOISE GENERATOR/FILTER

The output of the random noise generator feeds to the internal noise filter circuit. The noise filter rounds off the square-wave output of the noise generator, thereby reducing the high-frequency content of the noise waveform.

## MIXER

The mixer logic selects inputs from the noise filter, and feeds the output to the envelope generator and modulator section.

## ONE-SHOT LOGIC

This may be accomplished by means of a momentary switch, or by a square-wave input at pin 9. The one-shot logic is operable only when the proper attack/decay logic selection is made. The one-shot logic is used for short-duration sounds,

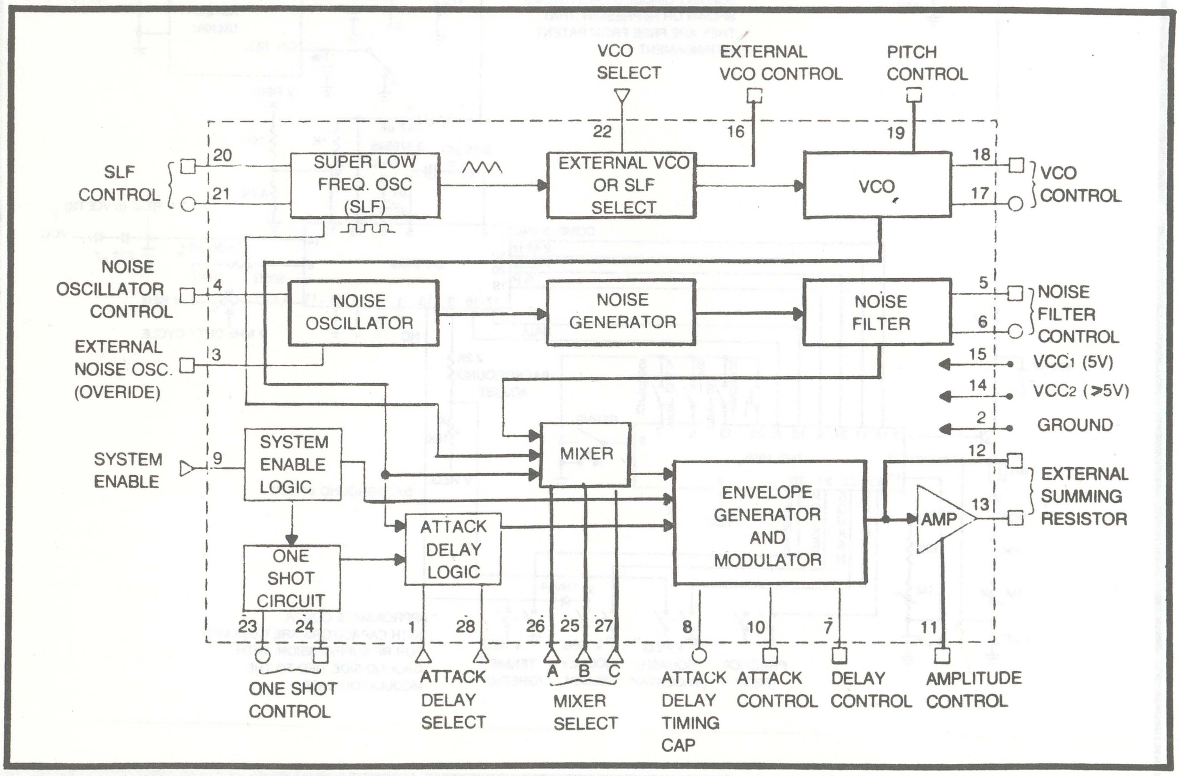



Fig. 6-10. Block diagram for complex sound generator SN76477.

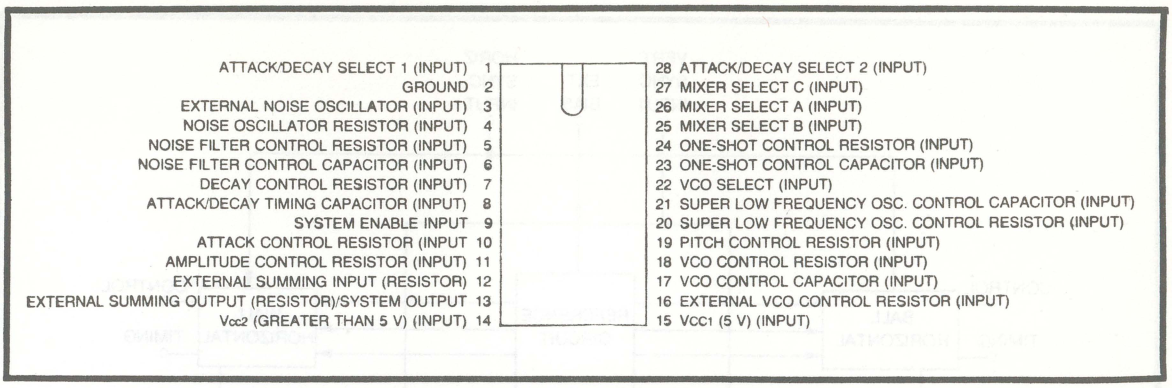



**Fig. 6-11. Pin assignment for SN76477.**

rather than continuous sounds. Examples of typical sounds are gunshots, explosions, bells, whistles, etc.

The complex sound generator chip also has system enable logic and ADL (attack/delay logic) functions.

The chip pin assignment for the SN76477 is shown in Fig. 6-11.

## SN76427 WALL/BALL GENERATOR CHIP

Game chip features:

- Generates video signals for ball and one game wall.
- Generates wall and ball's horizontal and vertical size.
- Low-power TTL compatible.

### IC Description

The SN76427 is a low-power TTL compatible integrated circuit containing all the circuitry required to generate video signals for one wall and a ball. It is designed to interface with other video game ICs to provide a complete video game system. Note the block diagram of this IC in Fig. 6-12.

### IC PIN DESCRIPTIONS

**Horizontal and vertical sync inputs**—The externally generated system sync pulses are fed into these pins.

**Ball horizontal control and timing pins**—The voltage at the ball horizontal control pin sets the level at which the external ball horizontal timing capacitor is charged to. The voltage level at the control pin is determined by connection to the system's ball horizontal direction circuit. The higher the voltage, the further the ball position is from horizontal sync.

**Ball vertical control pin**—Connection is made from this pin through an external resistor to the ball's english (vertical) control. A capacitor to ground is also required.

**Ball vertical timing pin**—An external capacitor to ground is required.

**Wall video output**—Video information for one wall is present at this pin.

**Wall horizontal control and timing pins**—Voltage at the wall horizontal control pin sets the level that the external wall horizontal timing capacitor is charged to. The higher the voltage, the further the wall position is from horizontal sync. The voltage at the control pin is determined by an external control pot.

**Wall vertical control and timing pins**—The voltage at the control pin sets the level which the timing capacitor is charged to. The higher the voltage, the further from vertical sync the goal (opening) appears. Size of the goal is determined by the timing capacitor.

**Goal control**—When this pin is grounded, the goal (opening) appears in the wall. When the pin is to Vcc, the goal is removed and a solid wall remains.

A typical schematic for the wall/ball generator is shown in Fig. 6-13.

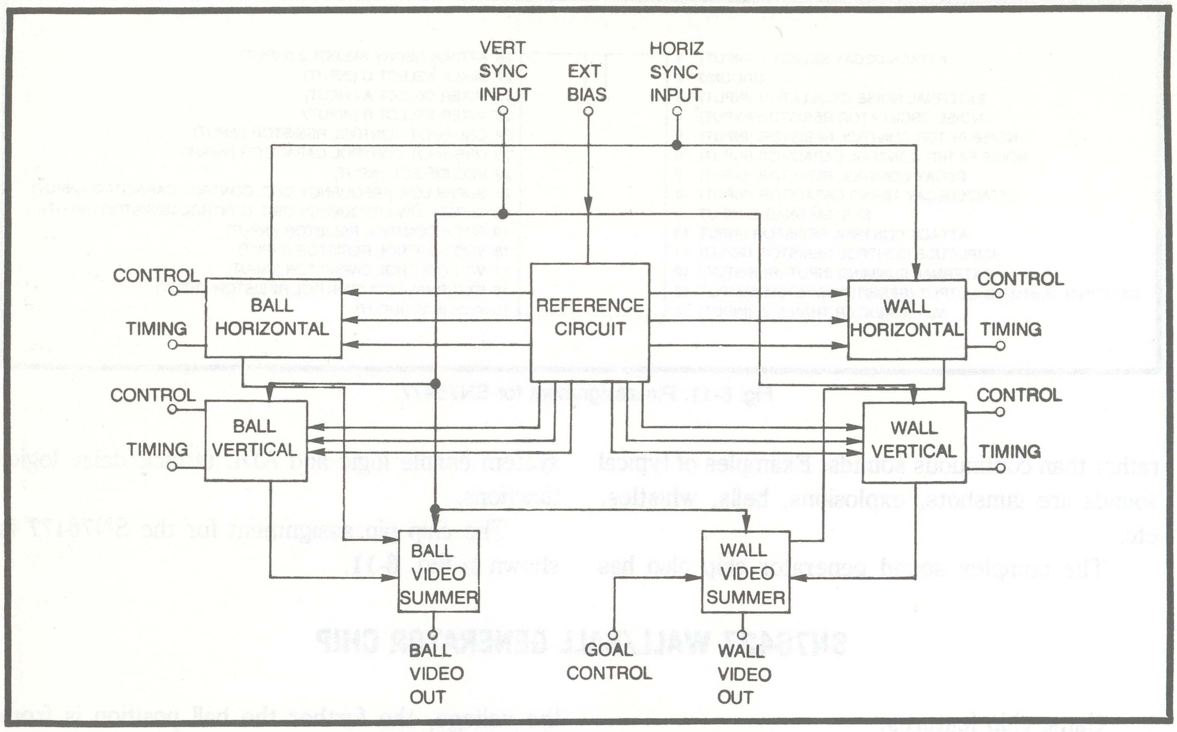



Fig. 6-12. Block diagram of the SN76427.

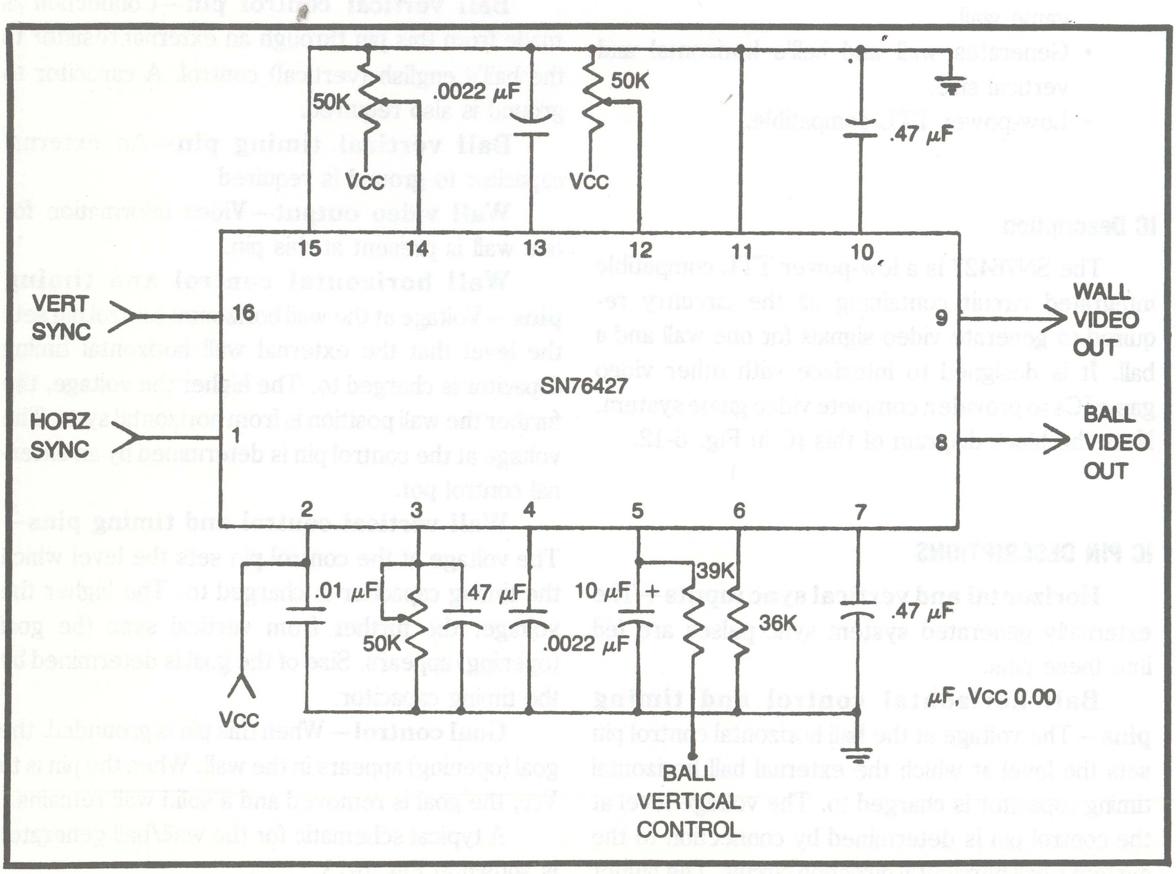



Fig. 6-13. Wall/ball generator schematic.

## SN76430N COLOR GENERATOR IC

### FEATURES

- Provides color composite video signal.
- Produces horizontal and vertical sync pulses.
- Built-in video summing section.

### CIRCUIT DESCRIPTION

The SN76430N utilizes low-power Schottky TTL technology to provide a color composite video output signal, video summing, and horizontal and vertical synchronization pulses in a complete video game system. Clock reference is a 3.58 MHz crystal. Of course, the chip is TTL and CMOS compatible. Block diagram for SN76430N chip is shown in Fig. 6-14.

### IC OPERATION

The circuit generates horizontal and vertical sync pulses from a 3.58 MHz internal oscillator. The chip also contains a video summer accepting video information from five video inputs (pins 16, 17, 18, 19, and 20). A composite video waveform is generated containing horizontal and vertical blanking, horizontal and vertical sync, color burst background video information, spot video information (players, walls, balls, score, etc.), and serration pulses.

Color burst begins at the end of horizontal sync and continues for 14 cycles of the subcarrier (3.58 MHz), and is present on all lines except those where serration pulses are present. The color yellow is assigned to any information fed to video inputs 16

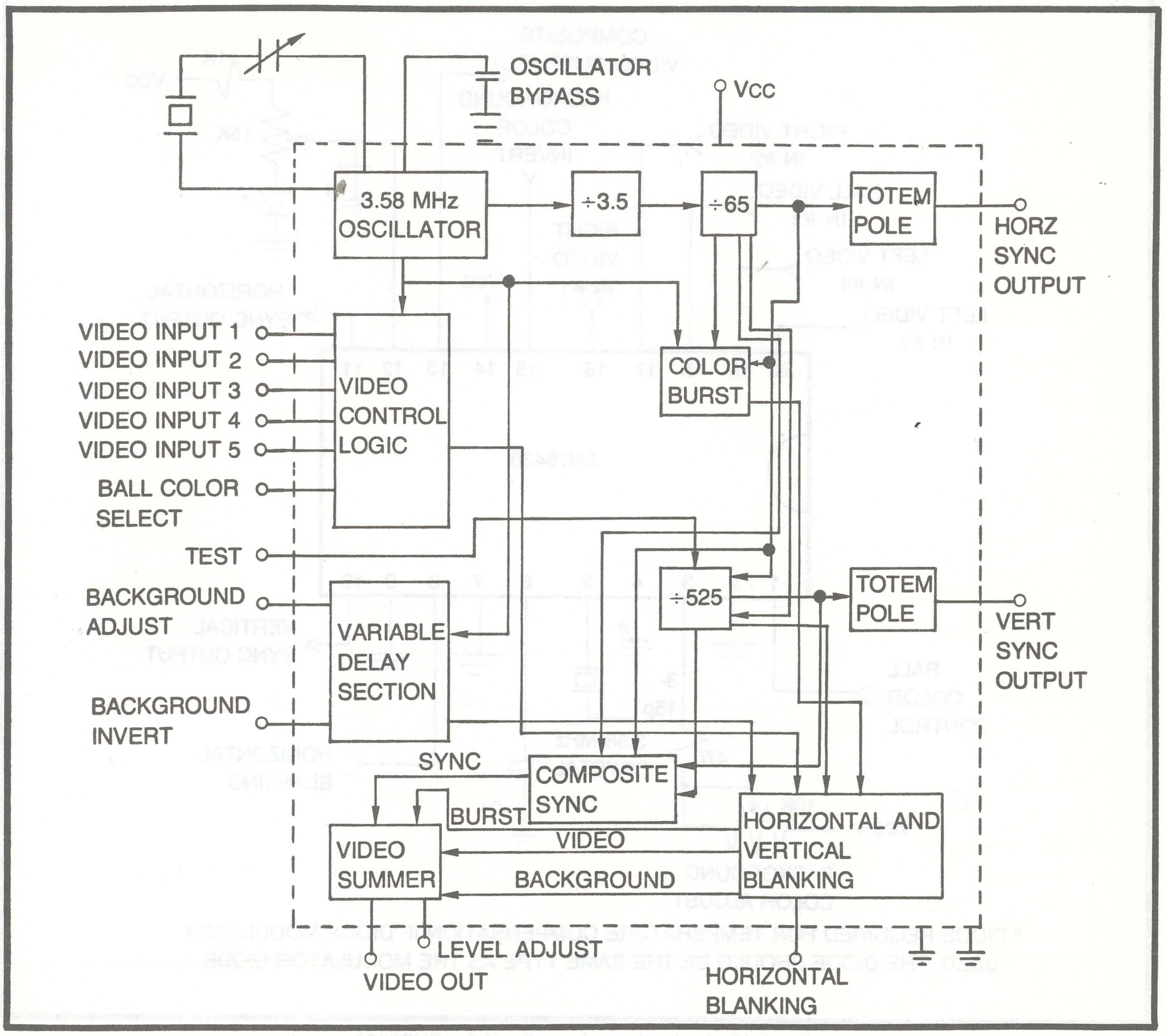



Fig. 6-14. Block diagram for the SN76430N IC.

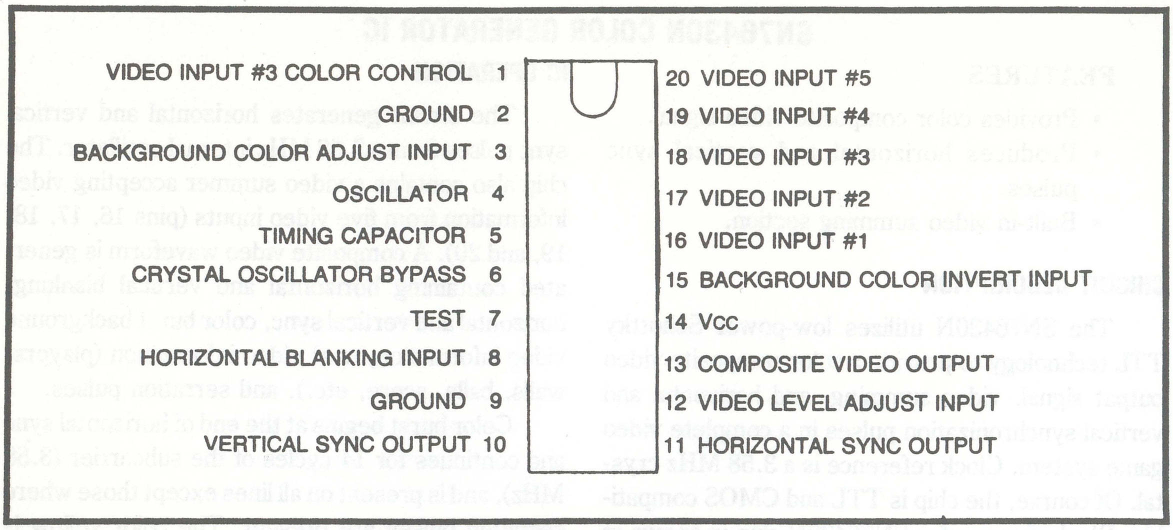



Fig. 6-15. SN76430N IC pin assignment.

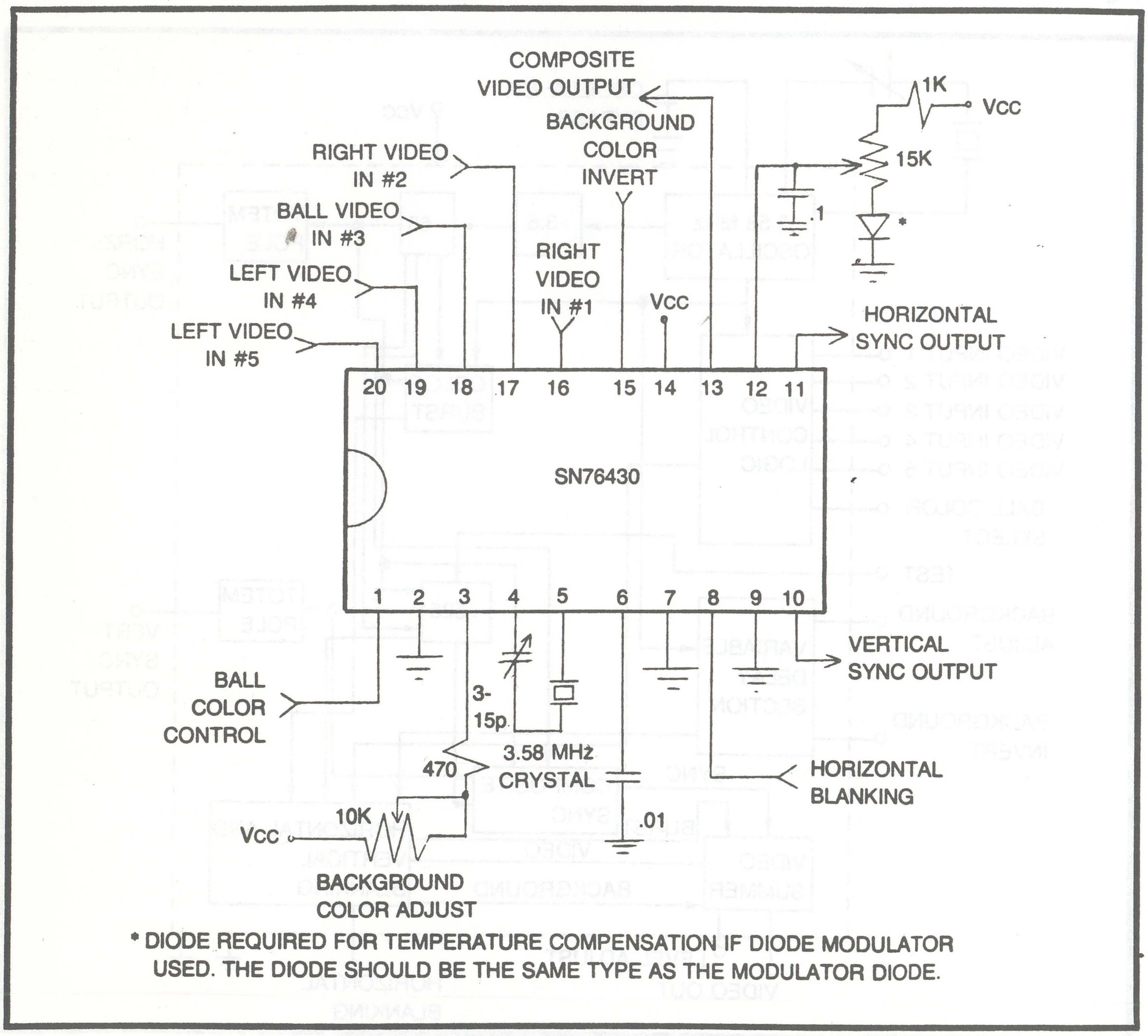



Fig. 6-16. Application schematic of the SN76430.

and 17. The color phase is the same as burst. Light-blue color is assigned to any information fed to video input pins 19 and 20. The information fed to pin 18 is yellow when pin 1 is a logic *zero*, matching the yellow assigned to pins 16 and 17. When pin 1 is switched to a logic *one*, the information at 18 is changed to the light-blue color, matching the light-blue color assigned to pins 19 and 20.

Background color is adjustable by raising or lowering the DC level into pin 3, with an adjustment of about 180° possible. A background color inversion of 195° from pin 3 setting may be obtained by applying a logic *one* to the background color invert pin (pin 15).

Horizontal and vertical sync outputs are totem-pole type, and compatible with standard TTL and CMOS circuits. Horizontal sync pulse width is approximately 4.85 $\mu$s. Vertical sync pulse width is three horizontal sync pulses. Vertical blanking begins 3 horizontal lines before vertical sync, and continues for 19 horizontal lines. Horizontal blanking (generated externally, and applied at pin 8) and vertical blanking will eliminate video signals, excluding burst.

Refer to Fig. 6-15 for pin assignment of SN76430N chip. A typical game application schematic for the SN76430N IC is shown in Fig. 6-16.

## SN76431N IC DUAL OSCILLATOR

The SN76431N is a low-power TTL compatible IC containing all of the circuitry required to provide two oscillator clocks for controlling the horizontal and vertical positions of two complex characters used in some TI game circuits. Note block diagram in Fig. 6-17.

### CHIP OPERATION

The frequency of each oscillator is determined by the RC network at pins 7 and 11. Pin 7 is the frequency adjust for oscillator 1 and pin 11 is the frequency adjust for oscillator 2. When used with the complex character circuits, a 1.5 MHz output frequency is required. The RC values for this output are shown in the typical application schematic shown in Fig. 6-18.

The horizontal position of the characters are determined by where the oscillators are turned on during each line of horizontal scan, gating the complex character circuit. The oscillator-on position

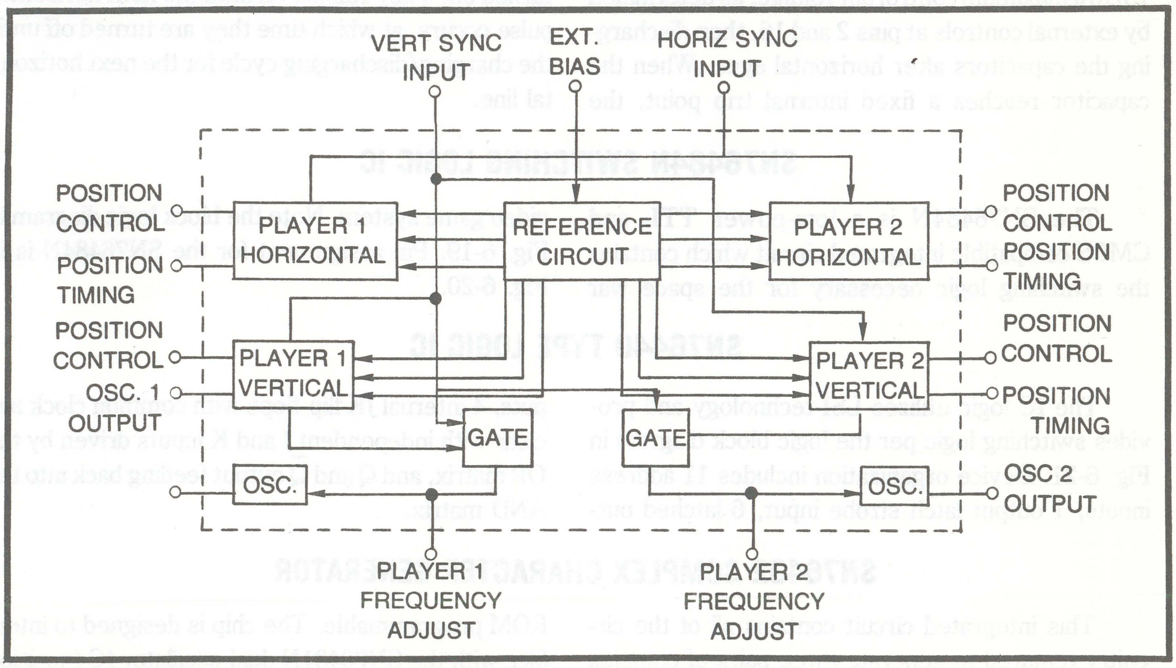



Fig. 6-17. Block diagram of the SN76431N IC.

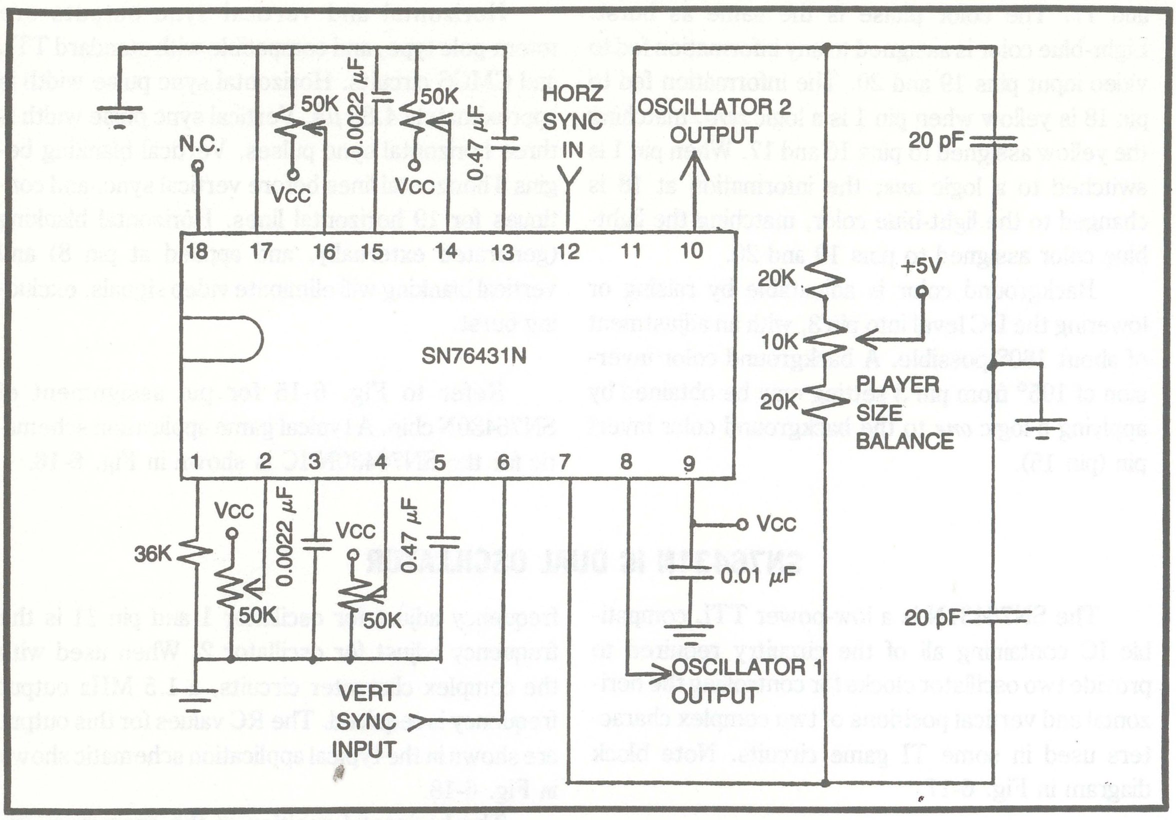



Fig. 6-18. Application schematic for the SN76431N chip.

(with respect to horizontal sync) is determined by charging the external timing capacitor (pins 3 and 15) to a maximum control pin voltage, as determined by external controls at pins 2 and 16, then discharging the capacitors after horizontal sync. When the capacitor reaches a fixed internal trip point, the oscillators are turned on. The higher the control voltage, the further from sync the oscillator is turned on. They remain on until the next horizontal pulse occurs, at which time they are turned off until the charging/discharging cycle for the next horizontal line.

## SN76484N SWITCHING LOGIC IC

The SN76484N is a low-power TTL and CMOS compatible integrated circuit which contains the switching logic necessary for the space war video game system. Note the block logic diagram in Fig. 6-19. Pin assignment for the SN76484N is in Fig. 6-20.

## SN76440 TYPE LOGIC IC

The IC logic utilizes LSI technology and provides switching logic per the logic block diagram in Fig. 6-21. Device organization includes 11 address inputs, 1 output latch strobe input, 6 latched outputs, 4 internal JK flip-flops with common clock and clear with independent J and K inputs driven by the OR matrix, and Q and $\bar{Q}$ output feeding back into the AND matrix.

## SN76432 COMPLEX CHARACTER GENERATOR

This integrated circuit contains all of the circuitry required to generate three pairs of complex characters for a video game. The characters are ROM programmable. The chip is designed to interface with the SN76431N dual-oscillator IC (position controller) to add these characters to a video game

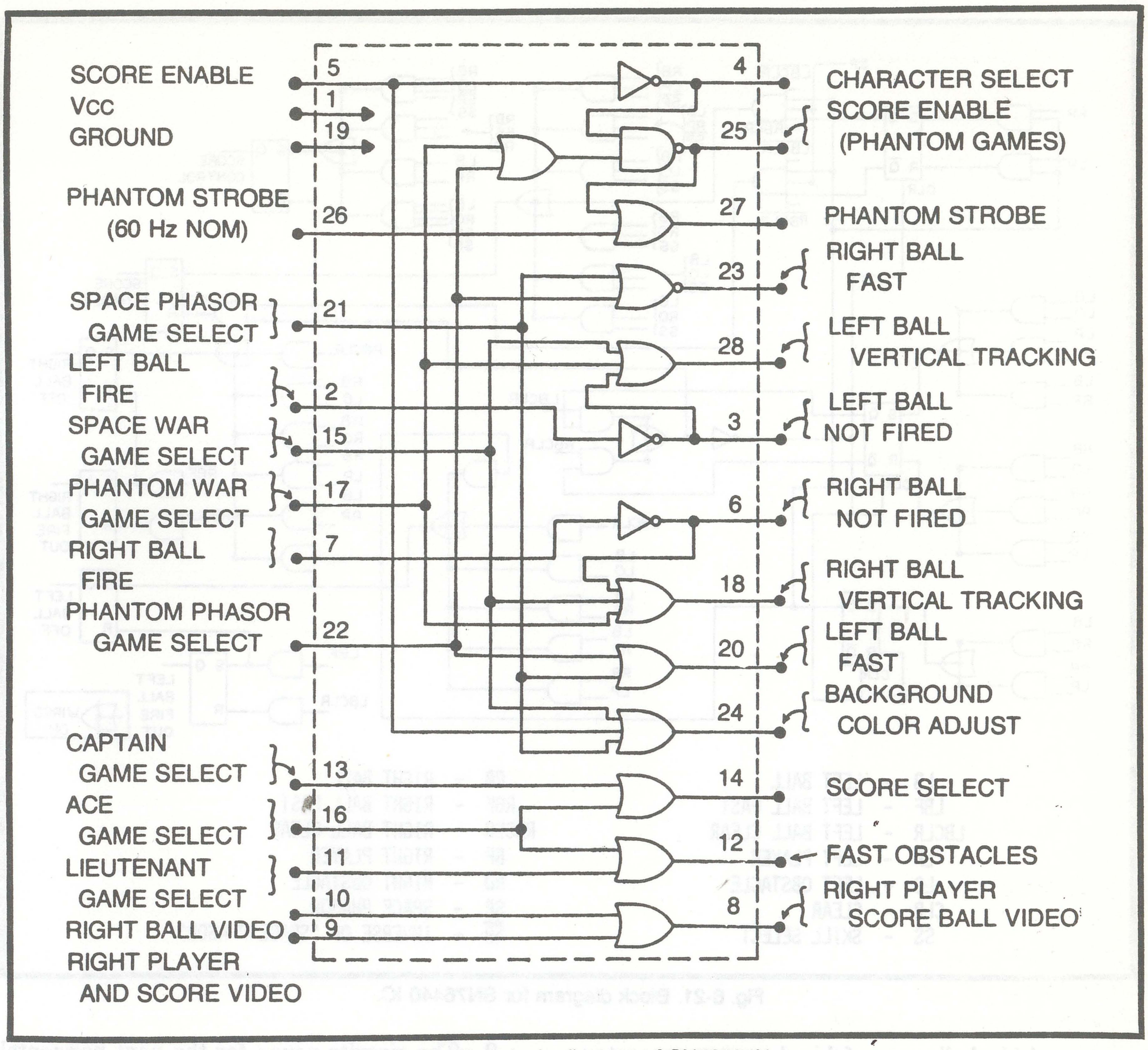



**Fig. 6-19. Block logic diagram of SN76484N.**

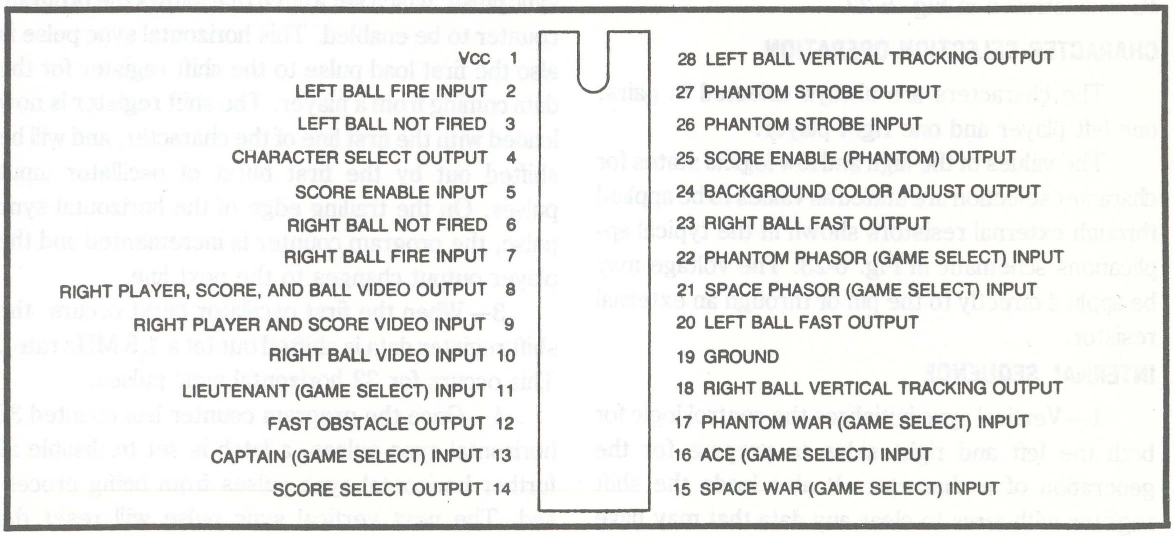



**Fig. 6-20. Pin assignment for SN76484N.**

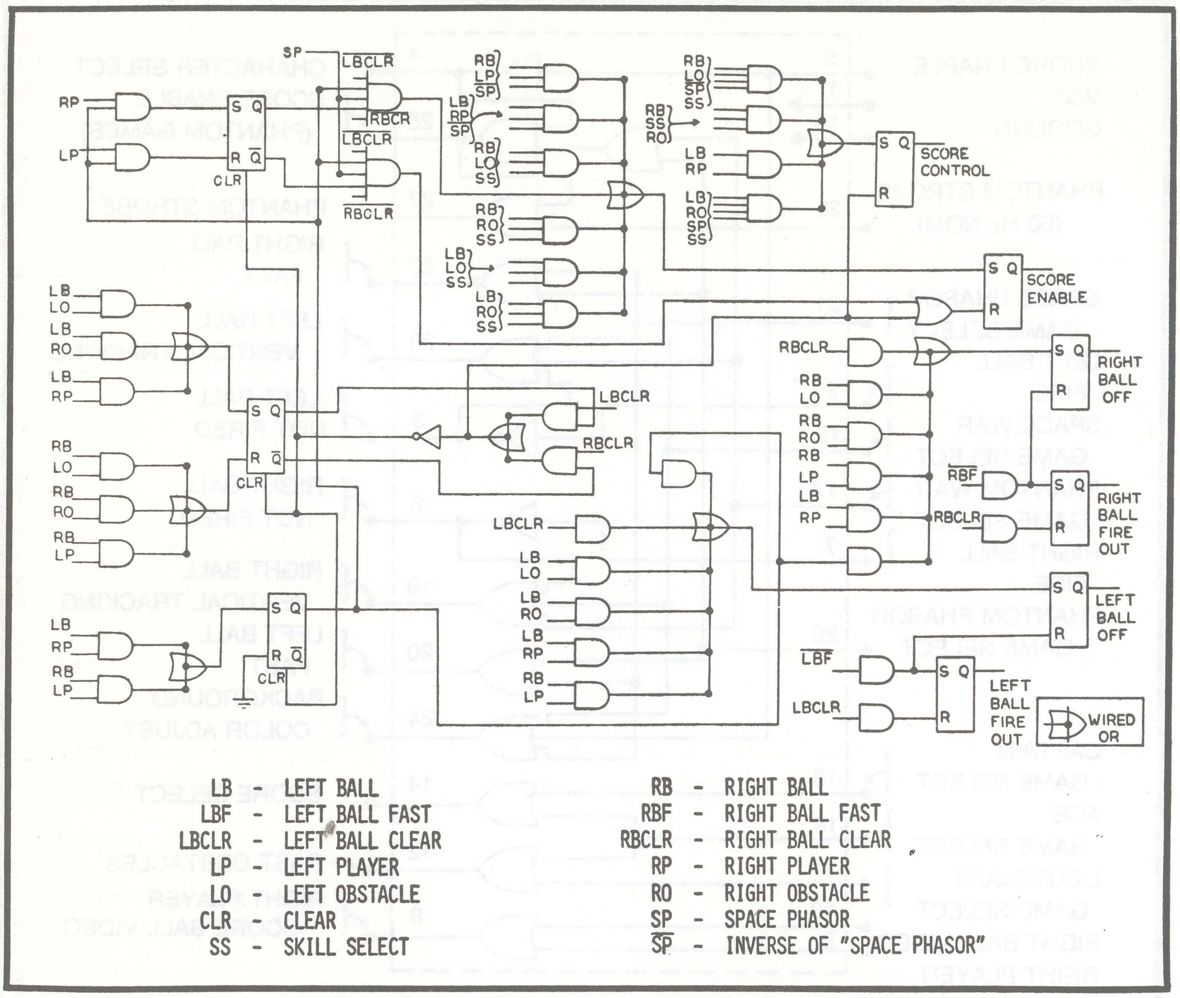



**Fig. 6-21. Block diagram for SN76440 IC.**

system. A block diagram of this character generator IC is illustrated in Fig. 6-22.

## CHARACTER SELECTION OPERATION

The characters are always selected in pairs: one left player and one right player.

The values of the high and low logical states for character selection are stated as values to be applied through external resistors shown in the typical applications schematic in Fig. 6-23. The voltage may be applied directly to the pin or through an external resistor.

## INTERNAL SEQUENCE

1—Vertical sync initializes the control logic for both the left and right sides to prepare for the generation of a character. It also loads the shift register with *zeros* to clear any data that may have been left from the previous frame.

2—The circuits pause for the next horizontal sync pulse, which set a latch that allows the program counter to be enabled. This horizontal sync pulse is also the first load pulse to the shift register for the data coming from a player. The shift register is now loaded with the first line of the character, and will be shifted out by the first burst of oscillator input pulses. On the trailing edge of the horizontal sync pulse, the program counter is incremented and the player output changes to the next line.

3—When the first oscillator burst occurs, the shift register data is shifted out (at a 1.5 MHz rate). This occurs for 32 horizontal sync pulses.

4—Once the program counter has counted 32 horizontal sync pulses, a latch is set to disable all further horizontal sync pulses from being processed. The next vertical sync pulse will reset the latch.

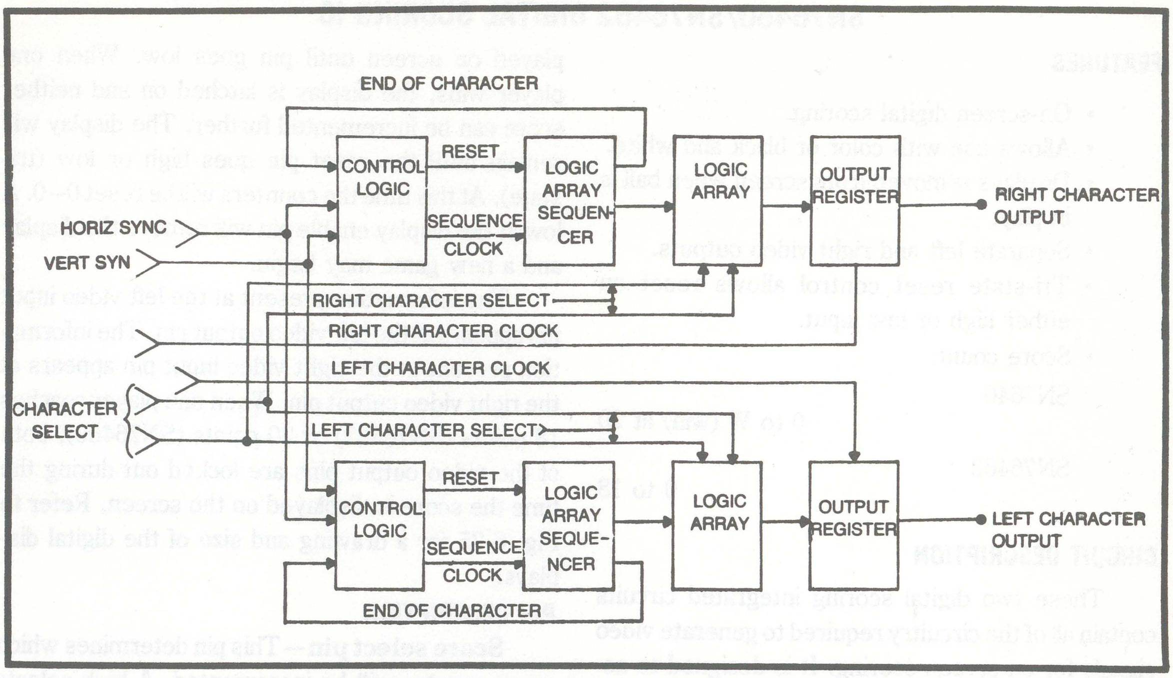



Fig. 6-22. Block diagram of complex character generator SN76432.

5—The program counter is set up such that every second horizontal sync pulse changes the player output. This results in identical information being shifted out for two consecutive lines.

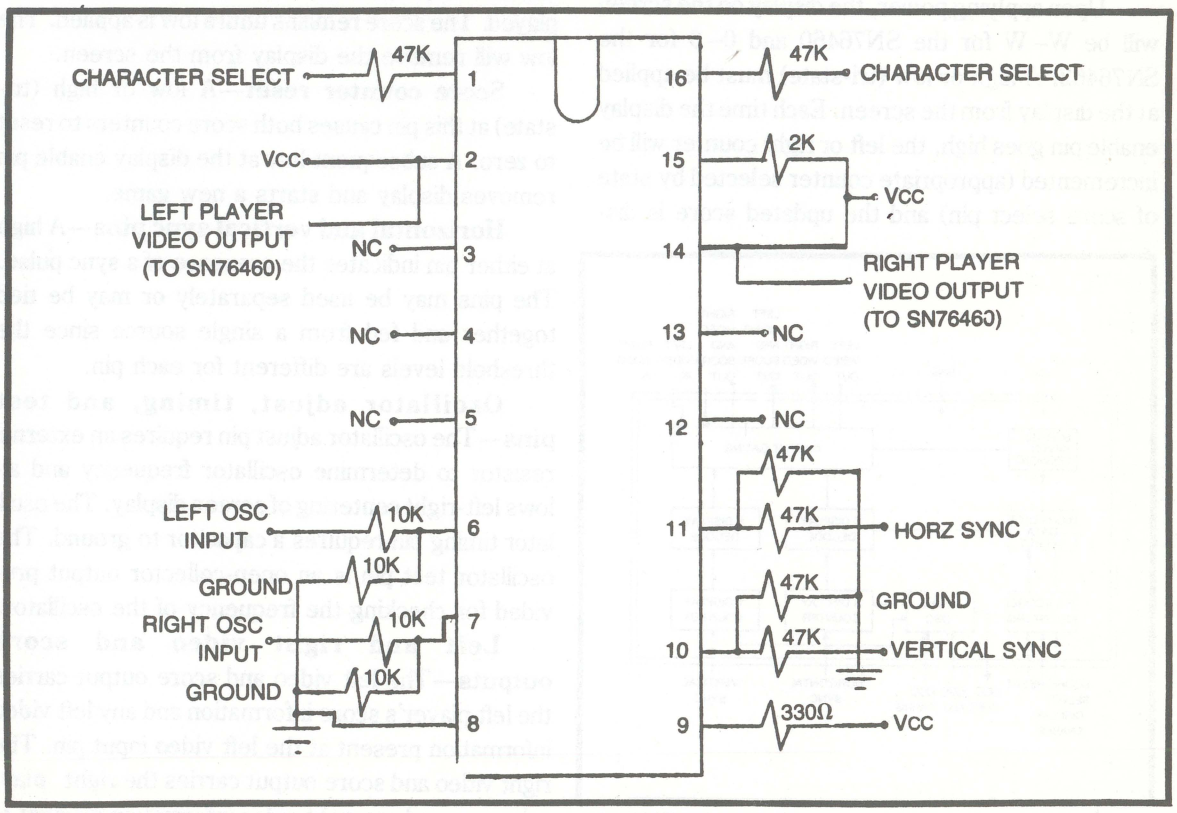



Fig. 6-23. Applications schematic for SN76432.

# SN76460/SN76462 DIGITAL SCORING IC

## FEATURES

- On-screen digital scoring.
- Allows use with color or black and white.
- Displays removed from screen when ball is in play.
- Separate left and right video outputs.
- Tri-state reset control allows reset on either high or low input.
- Score count:

  SN7640

  0 to W (win) at 20

  SN76462

  0 to 18

## CIRCUIT DESCRIPTION

These two digital scoring integrated circuits contain all of the circuitry required to generate video signals for on-screen scoring. It is designed to accept synchronization pulses, accept left/right score information, and to provide separate left and right video outputs. Note the block diagram of a scoring IC in Fig. 6-24.

Upon applying power, the display on the screen will be W–W for the SN76460 and 0–0 for the SN76462. A high or low (tri-state) must be applied at the display from the screen. Each time the display enable pin goes high, the left or right counter will be incremented (appropriate counter selected by state of score select pin) and the updated score is displayed on screen until pin goes low. When one player wins, the display is latched on and neither score can be incremented further. The display will remain until the reset pin goes high or low (tri-state). At this time the counters will be reset 0–0. A low at the display enable pin will remove the display and a new game may begin.

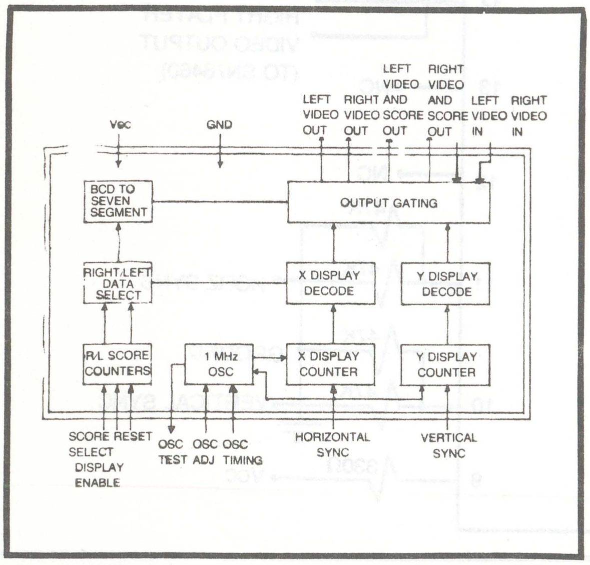



Fig. 6-24. Block diagram for scoring IC SN76460/SN76462.

The information present at the left video input pin appears at the left video output pin. The information present at the right video input pin appears at the right video output pin. When one player reaches 18 points (SN76462) or 20 points (SN76460), both of the video output pins are locked out during the time the score is displayed on the screen. Refer to Fig. 6-25 for a drawing and size of the digital displays.

## PIN DESCRIPTION

**Score select pin**—This pin determines which score counter will be incremented. A high selects the left counter. A low selects the right counter.

**Display enable pin**—When a high is fed to this pin, a one-shot clock is enabled which increments the proper counter, and the score is displayed. The score remains until a low is applied. The low will remove the display from the screen.

**Score counter reset**—A low or high (tri-state) at this pin causes both score counters to reset to zero. A subsequent low at the display enable pin removes display and starts a new game.

**Horizontal and vertical sync pins**—A high at either pin indicates the presence of a sync pulse. The pins may be used separately or may be tied together and fed from a single source since the threshold levels are different for each pin.

**Oscillator adjust, timing, and test pins**—The oscillator adjust pin requires an external resistor to determine oscillator frequency and allows left-right centering of screen display. The oscillator timing pin requires a capacitor to ground. The oscillator test pin is an open-collector output provided for checking the frequency of the oscillator.

**Left and right video and score outputs**—The left video and score output carries the left player's score information and any left video information present at the left video input pin. The right video and score output carries the right player's score and any right video information present at

the right video input pin. When one player wins, the video information is locked out and only the score information is present. After being reset, the video is restored. These outputs may be tied together.

**Left and right video input/output pins**—The information present at the left video input appears at the left video output pin. The same holds true for the right video information. When 18 points (SN76462) or 20 points (SN76460) are reached both video outputs are locked out.

A typical schematic diagram for the digital scoring IC and mechanical data is found in Fig. 6-26.

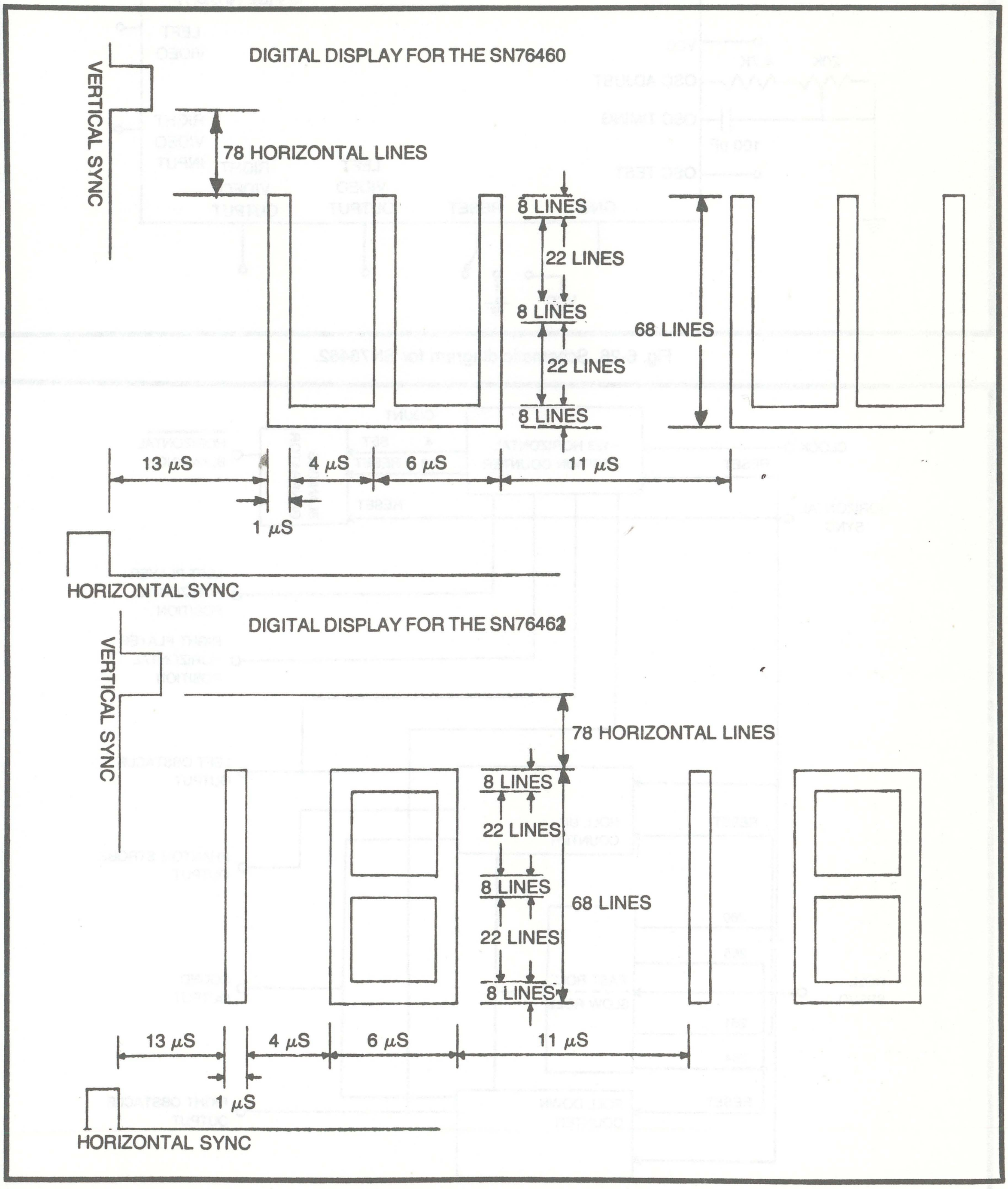



Fig. 6-25. Digital display for scoring ICs.

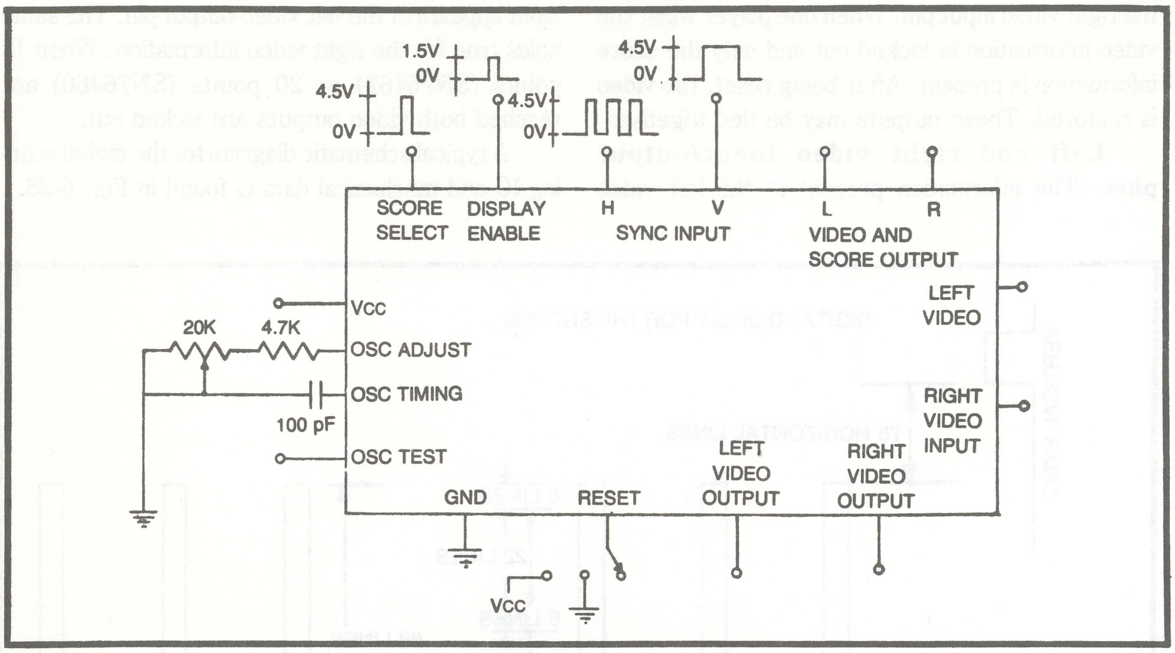



Fig. 6-26. Schematic diagram for SN76462.

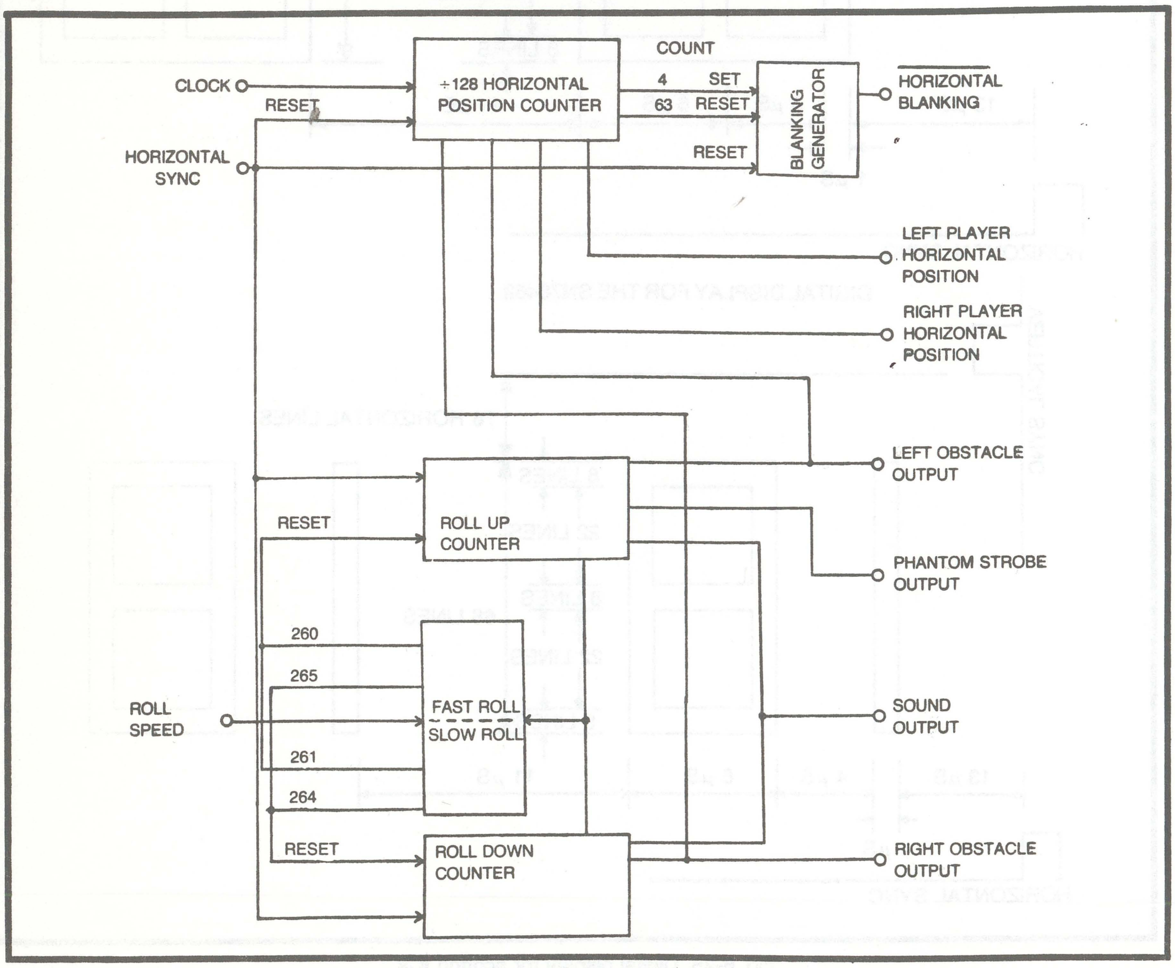



Fig. 6-27. Block diagram for SN76483N.

| | | |
|---|---|---|
| GAME 1 | SPACE JUNIOR | SPACE WAR GAME GROUP |
| GAME 2 | SPACE CADET | SPACE WAR GAME GROUP |
| GAME 3 | SPACE LIEUTENANT | SPACE WAR GAME GROUP |
| GAME 4 | SPACE CAPTAIN | SPACE WAR GAME GROUP |
| GAME 5 | SPACE ACE | SPACE WAR GAME GROUP |
| GAME 6 | PHANTOM JUNIOR | PHANTOM WAR GAME GROUP |
| GAME 7 | PHANTOM CADET | PHANTOM WAR GAME GROUP |
| GAME 8 | PHANTOM LIEUTENANT | PHANTOM WAR GAME GROUP |
| GAME 9 | PHANTOM CAPTAIN | PHANTOM WAR GAME GROUP |
| GAME 10 | PHANTOM ACE | PHANTOM WAR GAME GROUP |
| GAME 11 | PHASOR JUNIOR | SPACE PHASOR GAME GROUP |
| GAME 12 | PHASOR CADET | SPACE PHASOR GAME GROUP |
| GAME 13 | PHASOR LIEUTENANT | SPACE PHASOR GAME GROUP |
| GAME 14 | PHASOR CAPTAIN | SPACE PHASOR GAME GROUP |
| GAME 15 | PHASOR ACE | SPACE PHASOR GAME GROUP |
| GAME 16 | PHANTOM PHASOR JUNIOR | PHANTOM PHASOR GAME GROUP |
| GAME 17 | PHANTOM PHASOR CADET | PHANTOM PHASOR GAME GROUP |
| GAME 18 | PHANTOM PHASOR LIEUTENANT | PHANTOM PHASOR GAME GROUP |
| GAME 19 | PHANTOM PHASOR CAPTAIN | PHANTOM PHASOR GAME GROUP |
| GAME 20 | PHANTOM PHASOR ACE | PHANTOM PHASOR GAME GROUP |
| GAME 21 | PRACTICE GAMES | |

Fig. 6-28. Space War game list.

## SN76483N POSITION & OBSTACLE GENERATOR

The SN76483N IC contains all of the circuitry required to generate four obstacles. The right and left player horizontal position, sound generator, and the phantom strobe. Block diagram for this chip is shown in Fig. 6-27.

## SPACE WAR VIDEO GAME SYSTEM

This is a completely new concept in video games from Texas Instrument. It is not a paddle hit game. This is a game that challenges your ability to react to your opponent quickly. A list of the 21 different Space War games that can be played will be found in Fig. 6-28. Connections for the Space War game system is shown in Fig. 6-29. Complete schematic for space war system is shown in Fig. 6-30.

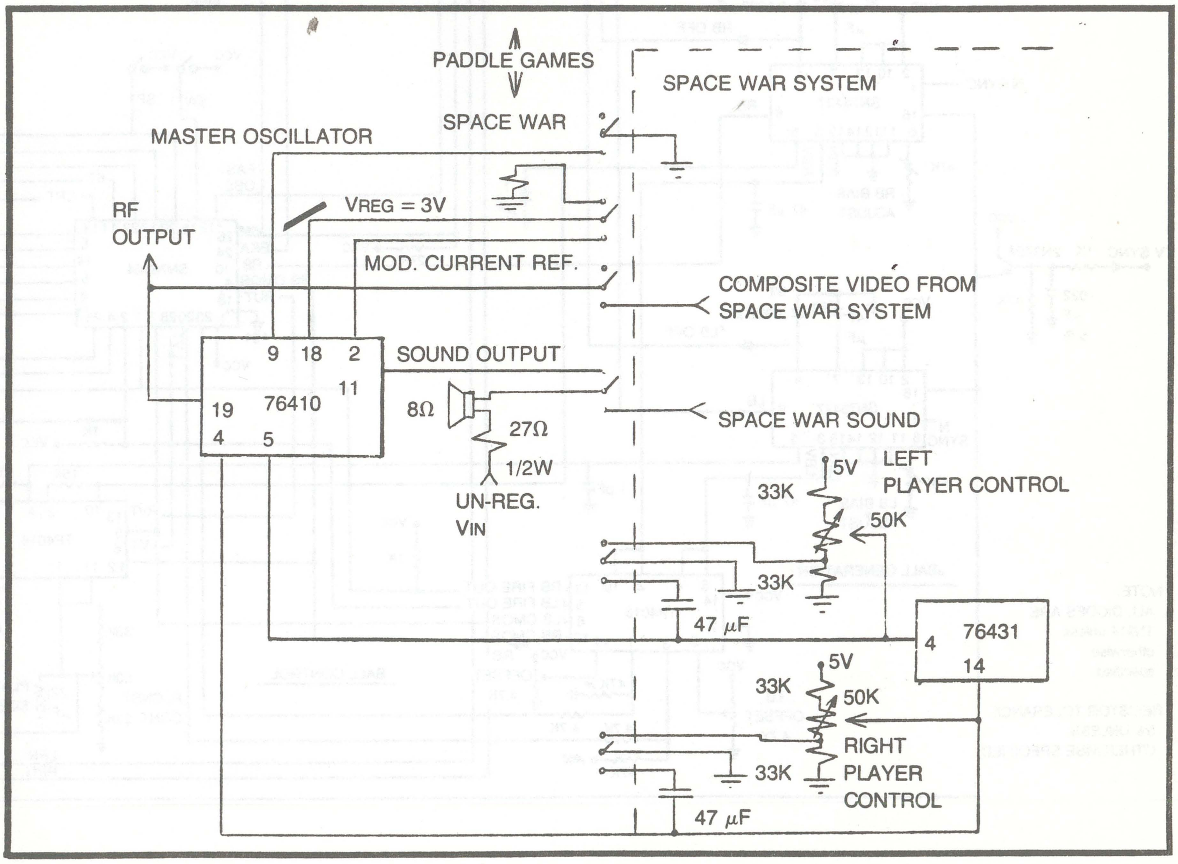



Fig. 6-29. Control connections for Space War games.

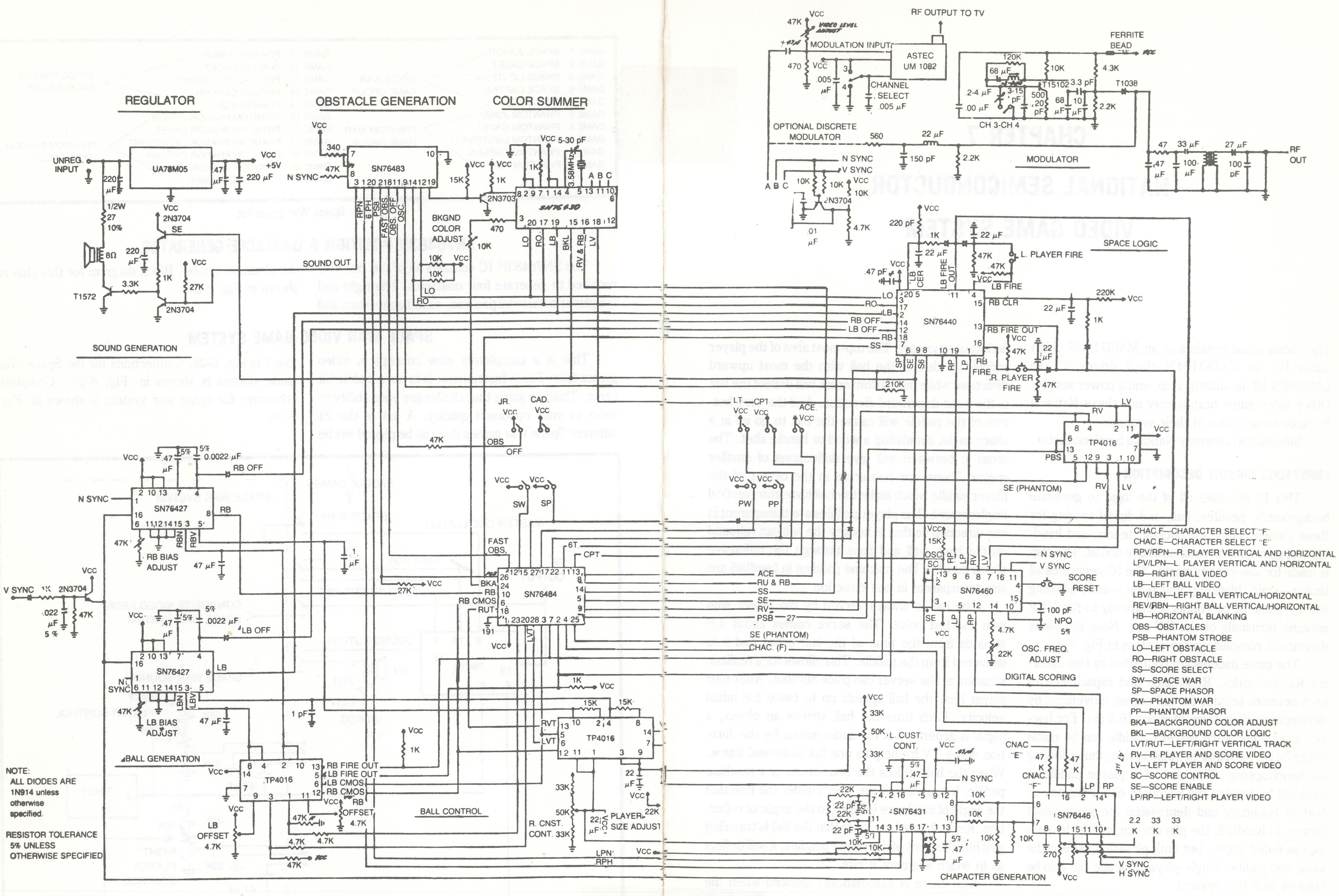



Fig. 6-30. Complete schematic for Space War game system.

# CHAPTER 7

# NATIONAL SEMICONDUCTOR VIDEO GAME SYSTEM

This video game consists of an MM57100N video game IC, an MM53104N clock driver IC, an LM1889N RF modulator chip, and a power supply. Other video game brands may use these National Semiconductor chips in their systems.

Information courtesy National Semiconductor.

## MM57100N CIRCUIT DESCRIPTION

This IC provides all of the logic to generate backgrounds, paddles, ball, and digital scoring for three games. They are hockey, tennis, and handball. All games are in color and have sound. The chip is made for low-cost systems. The IC generates all timing—sync, blanking, and burst—thus, allowing the TV game to be connected directly to the VHF antenna terminals of the TV set. Note the block diagram of complete game system in Fig. 7-1.

The game paddles are controlled by two external RC networks. Resistance and capacitance of each network provide for full-screen movement by developing a time delay of about 16.5 ms. For hockey and tennis, each player's paddle can be made either large, medium, or small in size, thus allowing for handicapping. The size of a player paddle is modified by moving the paddle to either the top or bottom boundary and depressing the game reset button. In handball, the players can modify the paddles as noted above, but both players must use the same size paddle. Single-player practice can also be created with this system.

The player paddles are divided into nine different areas that define eight angles that the ball will deflect upon impact. The top-most area of the player paddle will deflect the ball with the most upward direction, while the bottom areas will deflect the ball in the most downward direction. And the very bottom of the paddle will cause the ball to go up at a sharp angle, simulating a wood or handle shot. The areas in between will give deflections of smaller angles. There are two areas in the center of the player paddle which make the ball have zero vertical displacement. The player paddles are transparent in one direction so that in hockey the ball can rebound off the back wall and pass through the defensive player paddle. The machine paddles in handball are also transparent in one direction.

The ball is always served by the player who won the last point. The serve comes about 1.6 seconds from the time of the last score and it is delivered from the paddle. This allows for a realistic situation as the server can place his shot. After four player hits, the ball speeds up to twice the initial velocity. Each time the ball strikes an object, a signal is generated at the audio output for the duration of the TV frame plus one full additional frame. When the ball strikes the boundaries or a machine paddle, it bounces off the object under the rule that the angle of incidence is equal to the angle of reflection. Regardless of the angle that the ball is traveling as it hits the front of the player paddles, it will deflect as to which segment it hits.

The score is automatically blanked when the ball is put into play. It remains blanked until a miss is recorded; it is then properly displayed on the

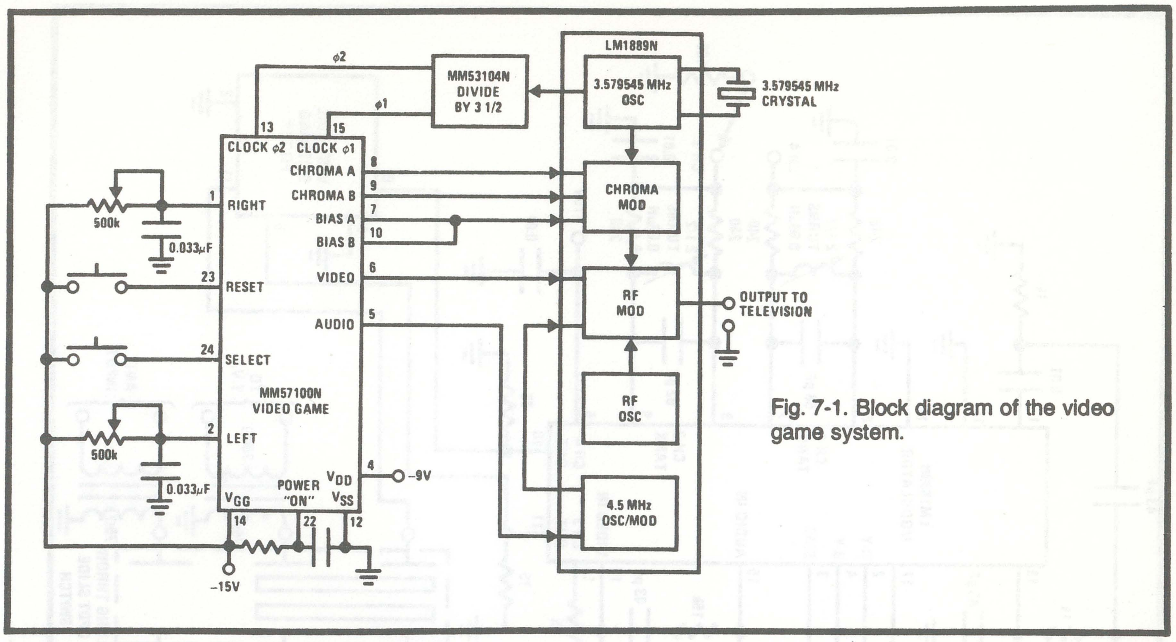



Fig. 7-1. Block diagram of the video game system.

screen. The game is completed when one player obtains 15 points. At this time, the score remains on and the serve is inhibited until the game reset button is depressed. Both the game reset and select inputs are debounced for 16.5 ms.

The video output signal contains horizontal and vertical blanking, horizontal and vertical sync, and the signal information necessary to generate the picture on a TV set via the RF antenna VHF input. Note schematic diagram of complete game in Fig. 7-2. The picture raster is not interlaced. Chroma outputs provide the color and burst information and are timed with the video. Note the connection diagram of MM57100N chip in Fig. 7-3.

## VIDEO GAME FEATURES

- Hockey, tennis, and handball.
- All games in full color.
- Ball speed doubles after fourth hit.
- Segmented paddles for automatic ball spin.
- Adjustable paddle size.
- Automatic digital scoring.
- Sound.
- Serve from paddles.
- RF signal output VHF band.

## TENNIS

The tennis game has a green court with a blue border, a yellow net, orange paddles, and light-green ball. Play starts when the machine automatically serves the ball crosscourt, left or right. The player who is served must hit the ball back to his opponent, who must then return it.

The ball speed increases after the fourth hit. When either player misses the ball, a point is scored for his opponent and the next serve comes to him after a 1.6-second wait. To increase the play value, the ball can bounce off both the top and bottom walls. In addition, before the play three sizes of paddles may be selected. The paddles are sectioned, giving a spin effect to the ball.

The score is automatically displayed in yellow. The score appears when the ball is missed and remains on until the ball is served. Play ends when the first player reaches 15 points. At the end of the game, the score remains on until the game is reset.

## HOCKEY

The hockey game has a blue playing field which is surrounded by yellow walls, two yellow player-controlled goalies, six light-yellow machine-controlled forwards, and a light-blue hockey puck.

Each player controls only his goalie, who moves in a vertical motion. In addition, each player has three forward men, who also move vertically. These men are not under player control but move up and down, as a group, automatically. As in tennis, the opening serve comes crosscourt and can come

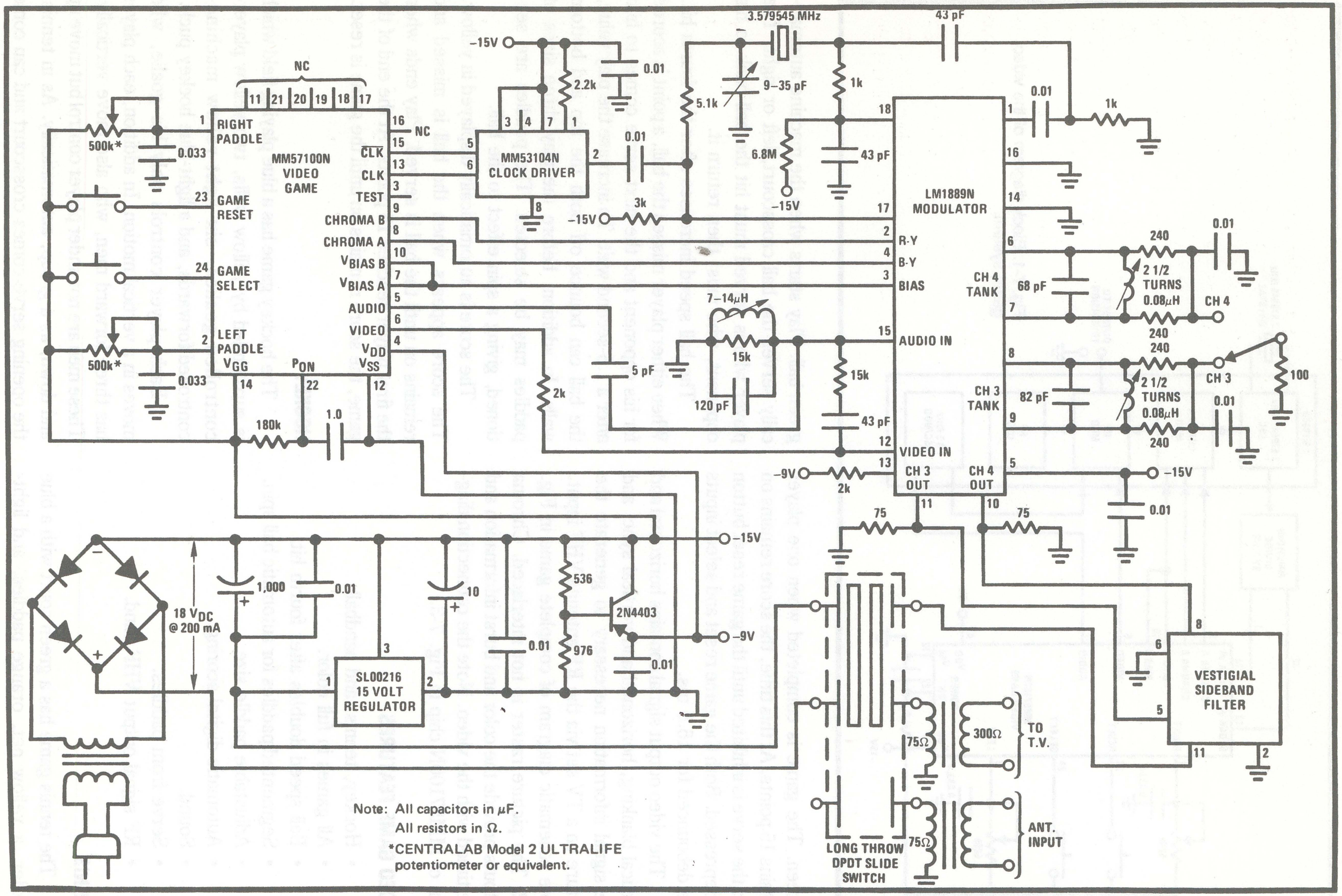



Fig. 7-2. Schematic of complete TV game.

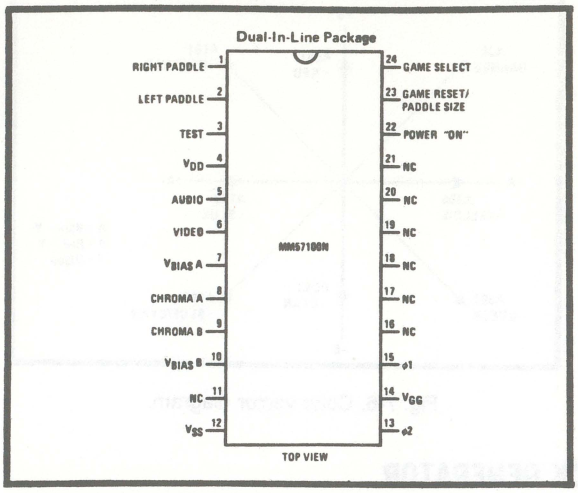



Fig. 7-3. Connection diagram for the MM57100N IC.

to either player. Further serves are to the player who has just lost a point.

## HANDBALL

Handball has a brown court, two paddles—one blue and one orange—and a yellow ball. It plays identical to tennis except only one player plays at a time and both are on the same side of the court, playing against the opposite wall. After the ball is served, the serving player disappears from the screen and the other player's paddle appears. He must hit it, or he loses the point and the other player serves again. The paddle that makes the hit disappears and the other paddle comes on the screen. The other player must return it to the wall. The object of the game is to keep the ball in continuous play by hitting it to the backcourt wall. The ball can be deflected off three sides: top, bottom, and right wall. The first player to score 15 wins. The score colors match the paddle colors—one blue and one orange.

| ELEMENT | CHROMA OUTPUT | VIDEO OUTPUT | APPR. COLOR | APPR. SIZE | COMMENTS |
|---|---|---|---|---|---|
| Tennis Background | A1B0 | Light | Blue | | |
| Tennis Field | A0B3 | Dark | Cyan | 13.2 x 16.8 inches$^2$ | |
| Tennis Ball | A0B3 | Light | Cyan | 0.5 x 0.5 inches$^2$ | |
| Tennis Score | A3B0 | Light | Yellow | 4 x 5 inches$^2$ | Blanked during play |
| Tennis Net | A3B0 | Light | Yellow | 0.5 x 13.2 inches$^2$ | |
| Tennis Left Player | A3B1 | Light | Orange | 3 sizes | 2.4, 1.2 or 0.6 inches x 0.5 inches independent of other paddle |
| Tennis Right Player | A3B1 | Light | Orange | 3 sizes | 2.4, 1.2 or 0.6 inches x 0.5 inches independent of other paddle |
| Handball Background | A3B0 | Light | Yellow | | |
| Handball Field | A3B0 | Dark | Yellow | 13.2 x 16.8 inches$^2$ | |
| Handball Ball | A3B0 | Light | Yellow | 0.5 x 0.5 inches$^2$ | |
| Handball Left Score | A3B1 | Light | Orange | 4 x 5 inches$^2$ | Blanked during play |
| Handball Right Score | A1B0 | Light | Blue | 4 x 5 inches$^2$ | Blanked during play |
| Handball Left Player | A3B1 | Light | Orange | 3 sizes | 2.4, 1.2 or 0.6 x 0.5 inches, same as other paddle |
| Handball Right Player | A1B0 | Light | Blue | 3 sizes | 2.4, 1.2 or 0.6 x 0.5 inches, same as other paddle |
| Hockey Background | A1B0 | Dark | Blue | | |
| Hockey Field | A1B0 | Dark | Blue | 13.2 x 16.8 inches$^2$ | |
| Hockey Border | A3B0 | Light | Yellow | | |
| Hockey Puck | A1B0 | Light | Blue | 0.5 x 0.5 inches$^2$ | |
| Hockey Score | A3B0 | Light | Yellow | 4 x 5 inches$^2$ | Blanked during play |
| Hockey Left Player | A3B0 | Light | Yellow | 3 sizes | 2.4, 1.2 or 0.6 x 0 hes independent of oth ddle |
| Hockey Right Player | A3B0 | Light | Yellow | 3 sizes | 2.4, 1.2 or 0 ches independen paddle |
| Hockey Machine Forwards | A3B0 | Light | Yellow | 0.5 x 0.6 inches$^2$ | |
| Hockey Goals | A1B0 | Light | Blue | 4.6 x 0.5 inches$^2$ | Hole in the Border |

Fig. 7-4. Game colors and image size on a 25-inch TV screen.

| CHROMA A AND CHROMA B OUTPUTS | APPROXIMATE COLOR |
|---|---|
| A0, B0 | Light Gray |
| A0, B1 | Red |
| A0, B3 | Cyan |
| A1, B0 | Blue |
| A1, B1 | Magenta |
| A1, B3 | Blue Cyan |
| A3, B0 | Yellow |
| A3, B1 | Orange |
| A3, B3 | Green |
| $A_{BURST}$, B0 | Color Burst |

Fig. 7-5. Chroma outputs and their approximate color reproductions.

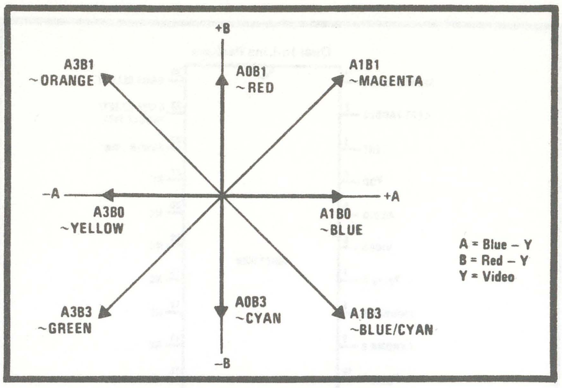



Fig. 7-6. Color vector diagram.

## MM53104 CLOCK GENERATOR

The MM53104 is an 8-pin monolithic CMOS clock generator designed to generate the two-phase nonoverlapping clocks required by the MM57100 TV game chip. Figure 7-7 shows the pin layout for this chip. Timing waveforms for this chip are illustrated in Fig. 7-8. Logic diagrams for the internal circuitry are shown in Fig. 7-9.

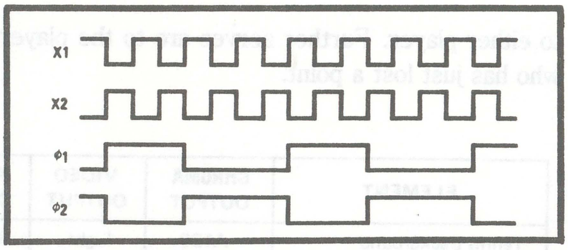



Fig. 7-8. Timing diagram of the MM53104N clock chip.

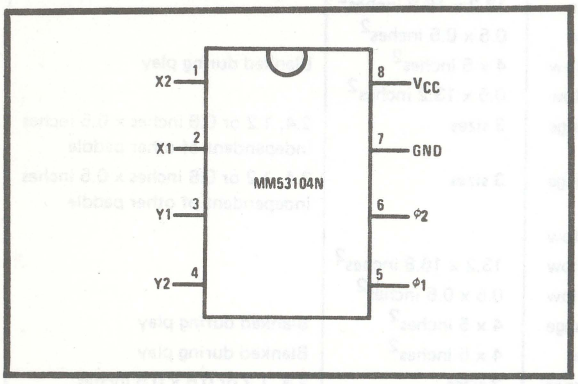



Fig. 7-7. Pin layout diagram for the MM53104N clock chip.

The clock chip contains two independent oscillator circuits that can either be driven by an external input or be used as a Colpitts-type oscillator (crystal oscillator). The first oscillator (X1-X2) is designed to operate at 3.58 MHz. The output is fed internally to a divide-by-3 1/2 counter to generate the 1.0227 MHz outputs, 01 and 02, required by the MM57100. The second oscillator (Y1-Y2) is a completely independent oscillator and is designed for a 4.5 MHz operation.

All pins are protected against static damage by diode clamps at both voltage input and ground connections. The clock IC directly drives the MM57100 chip and has a power consumption of 250 mW at 15V DC.

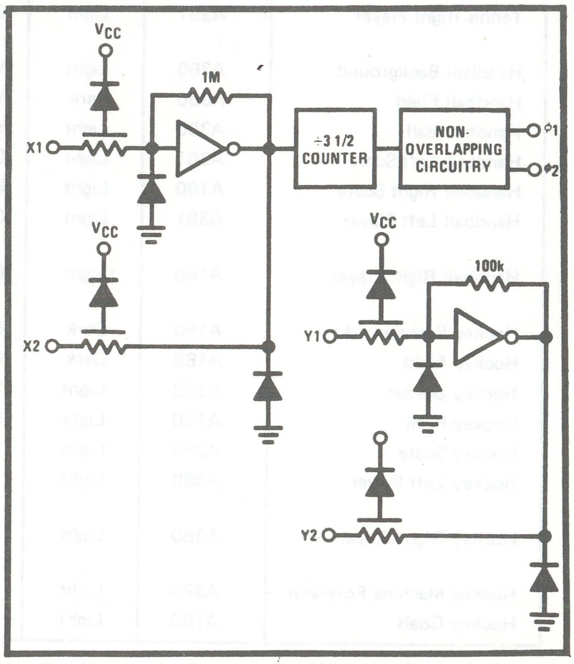



Fig. 7-9. Logic diagrams for MM53104N clock chip.

# VIDEO MODULATOR CHIP LM1889

The LM1889 IC is designed to interface audio, color-difference, and luminance signals to the antenna terminals of a TV receiver. It consists of a sound subcarrier oscillator, chroma subcarrier oscillator, quadrature chroma modulators, and RF oscillators and modulators for two low-band VHF channels. Note the block diagram of the LM1889 in Fig. 7-10.

The IC modulator allows video information from the game chip to be displayed on a conventional TV receiver. When used with the MM57100 and MM53104, a complete TV video game is formed.

## MODULATOR FEATURES

- DC channel switching
- 12V to 18V supply operation
- Excellent oscillator stability
- Low intermodulation products
- 5V P-P chroma reference signal
- May be used to encode composite video

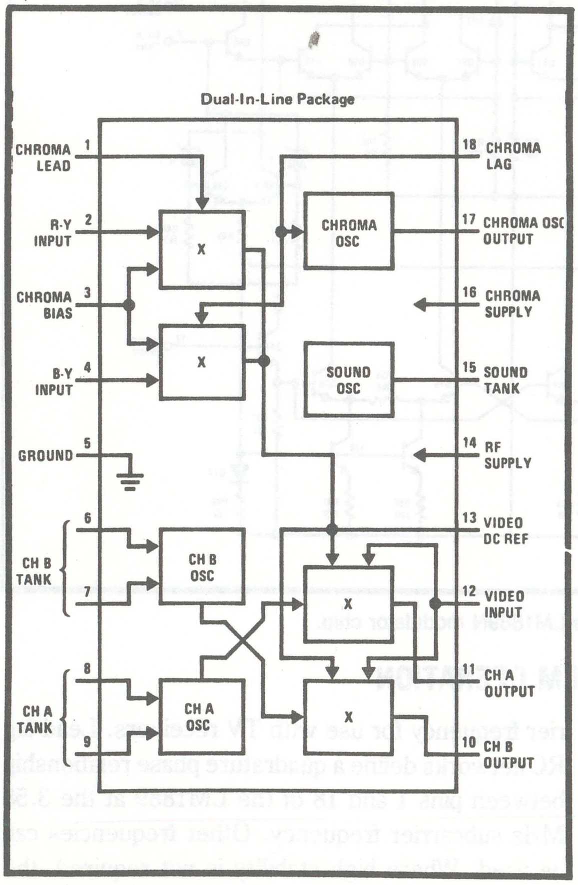



Fig. 7-10. Block diagram of the LM1889N modulator chip.

## LM1889 CIRCUIT DESCRIPTION

Referring to the inner workings of this chip in Fig. 7-11 we note the sound carrier oscillator is formed by differential amplifier Q3 and Q4, operated with positive feedback from pin 15 to the base of Q4.

The chroma oscillator consists of inverting amplifier Q16-Q17 and Darlington emitter follower Q11-Q12. An external RC and crystal network from pin 17 to pin 18 provides an additional 180° phase lag at the base of Q17 to produce oscillation at the crystal resonance frequency.

The feedback signal from the crystal is split in a lead-lag network to pins 1 and 18 to generate the subcarrier reference signals for the chroma modulators. The R−Y modulator consists of multiplier devices Q29-Q30 and Q21 through Q24, while the B−Y modulator consists of Q31-Q32 and Q25 through Q28. The multiplier outputs are coupled through balanced summing amplifier Q37-Q38 to the input of the RF modulators at pin 13. With zero offset at the lower pairs of the multipliers, no chroma output is produced. However, when either pin 2 or pin 4 is offset relative to pin 3 a subcarrier output current of proper phase is produced at pin 13.

The channel B oscillator consists of Q56 and Q57 cross-coupled through level-shift zener diodes Q54 and Q55. A current regulator, consisting of Q39 through Q43, is used to achieve RF stability for variations of power and temperature. The channel B modulator consists of multiplier devices Q58-Q59 and Q50 through Q53. The top quad (Q50 through Q53) is connected to the channel B tank through isolating devices Q48 and Q49. A DC offset between pins 12 and 13 offsets the lower pair to produce an output RF carrier at pin 10. That carrier is then modulated by both the chroma signal at pin 13 and the video and sound carrier signals at pin 12. The channel A modulator shares pins 12 and 13 with channel B, buffer Q45 and Q44 with channel B, and operates in an identical manner.

The current flowing through channel B oscillator diodes Q54 and Q55 is turned around in Q60, Q61, and Q62, creating source current for the channel B RF modulator. In the same manner, the channel A oscillator Q71 through Q74 uses turnaround Q77, Q78, and Q79 to feed the channel A modulator. The oscillators can be activated one at a time.

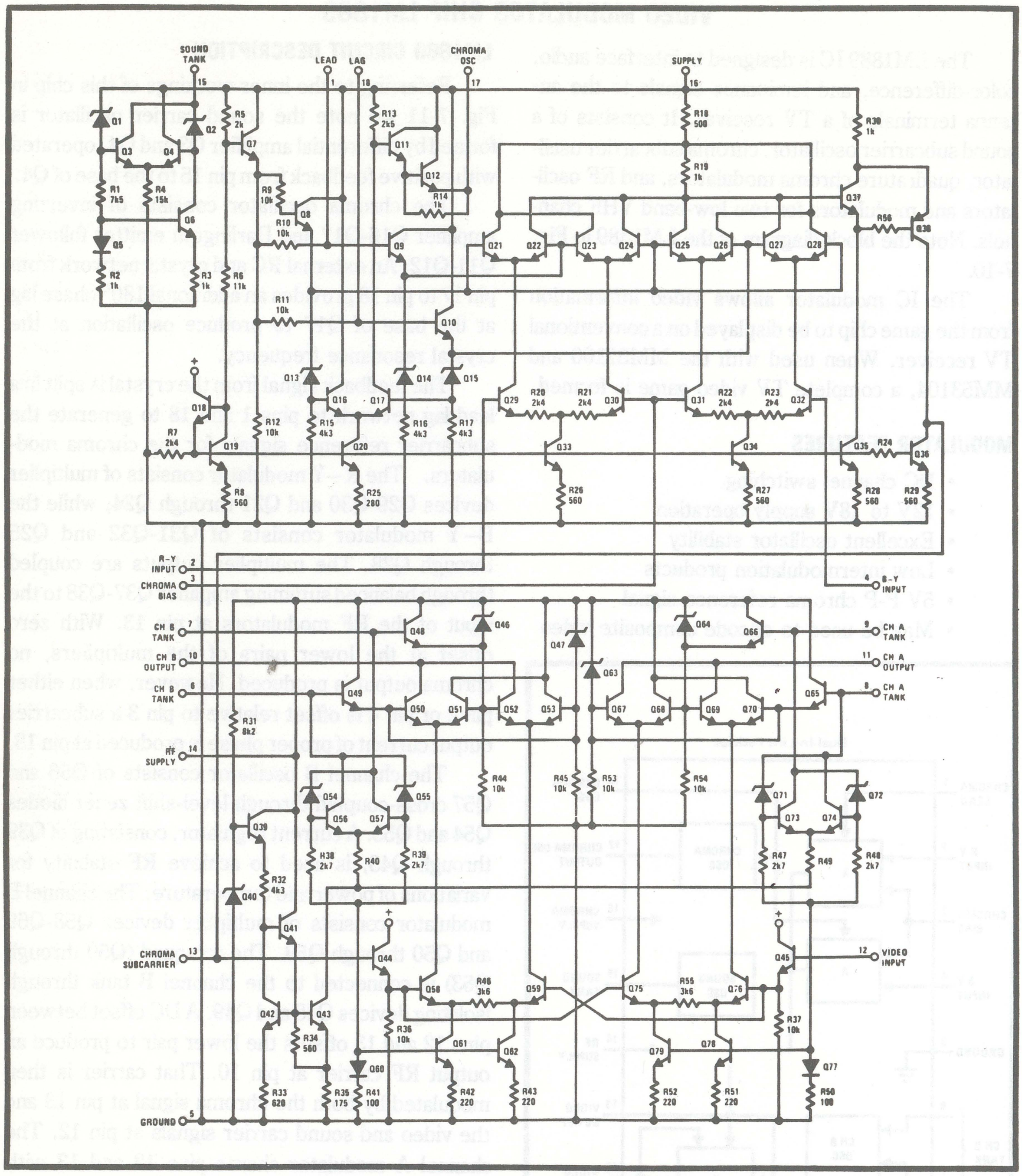



Fig. 7-11. Internal circuitry of the LM1889N modulator chip.

## VIDEO GAME SYSTEM OPERATION

Refer to Fig. 7-2 for the schematic diagram of the total video game system.

### SUBCARRIER OSCILLATOR

The subcarrier oscillator is a crystal-controlled design to ensure the stability required of the subcarrier frequency for use with TV receivers. Lead-lag RC networks define a quadrature phase relationship between pins 1 and 18 of the LM1889 at the 3.58 MHz subcarrier frequency. Other frequencies can be used. Where high stability is not required, the crystal can be replaced with a parallel resonant LC

tank circuit to provide a 2 MHz clock as an example. Note that since one of the chrominance modulators is internally connected to the feedback path of the oscillator, operation of the oscillator at other than the correct subcarrier frequency precludes chrominance modulation.

## CHROMINANCE MODULATION

The simplest method of chroma encoding is to define the quadrature phases provided at pins 1 and 18 (Fig. 7-10) as color-difference axes R−Y and B−Y. A signal at pin 2 (R−Y) will give a chrominance subcarrier output from the modulator with a relative phase of 90° compared to the subcarrier output produced by a signal at pin 4 (B−Y). Both color-difference signals must be DC coupled to the modulators. The zero signal DC level of both must be the same and within the common-mode range of the modulators.

## SOUND OSCILLATOR

Frequency modulation (FM) is achieved by using a 4.5 MHz tank circuit and deviating the center frequency via a capacitor. Switching a 5 pF capacitor (Fig. 7-12) to ground at a video-frequency rate will cause a 50 kHz deviation from 4.5 MHz. The coupling network to the video modulator input and the varactor diode bias must be included when the tank circuit is tuned to the center frequency.

## RF MODULATION

Two RF channels are available with carrier frequencies up to 100 MHz, which are determined by LC tank circuits at pins 6, 7, 8, and 9 (Fig. 7-12). The signal inputs (pins 12 and 13) to both modulators are common, but removing the power supply from an RF oscillator tank circuit will also disable that modulator.

To keep the DC content of the video signal, amplitude modulation of the RF carrier is done in one direction only, with increasing video (toward peak white) decreasing the carrier level. This means the active composite video signal at pin 12 must be offset with respect to pin 13, and the sync pulse should produce the largest offset. The offset voltage of pin 12 with respect to pin 13 should have the same polarity as the sync pulses.

## COMPOSITE VIDEO OUTPUT CHECK

When both chrominance and luminance modulation are being used, a good way to check the chrominance-to-luminance ratio before modulation on the RF carrier is as follows: Refer to Fig. 7-12 where the tank circuit of one RF oscillator has been replaced. Pin 8 is held to one diode voltage drop below pin 9, thereby offsetting the upper tank of the modulator, which now behaves as a cascade stage for the composite video signal. A 1.8K resistor, as a load at pin 11, gives a gain of about 0.5. If pin 11 is buffered by an external amplifier, composite video at 75Ω can be obtained for injection directly into the video stage of a TV receiver. Putting diode D1 in series with pin 9 instead of pin 8 will reverse the video polarity.

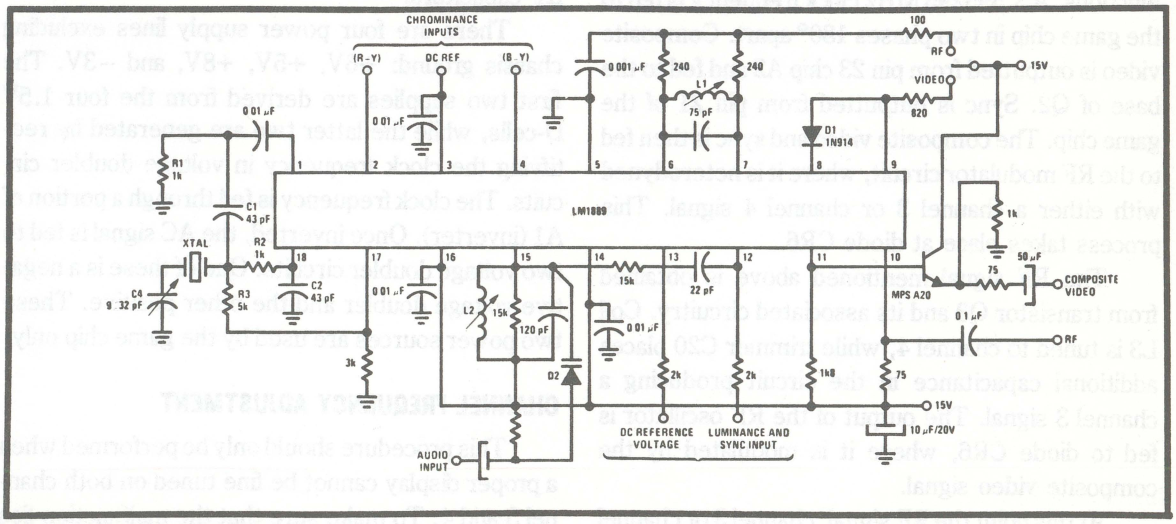



Fig. 7-12. Schematic diagram of the LM1889N modulator chip hooked up differently than shown in the general game schematic of Fig. 7-2. Here the chip is connected for luminance and chrominance encoding for composite video or RF outputs.

# CHAPTER 8

# PONG BY ATARI

Atari is one of the world leaders as far as video games go. They hold a good portion of the consumer market for home TV games and also a large portion of the coin-op market. The Pong game here, however, is the home-style consumer video game.

Atari manufactures several video games today. The Pong game is just a sample of its product line. Nonetheless, it will give you an idea of what this company's circuitry is like.

## GAME OPERATION

The Atari Pong game (Fig. 8-1) is not unlike many other brands, in that it incorporates a single microprocessor chip to generate most of the game functions. A 3.595295 MHz clock frequency is fed to the game chip in two phases 180° apart. Composite video is outputted from pin 23 chip A2 and fed to the base of Q2. Sync is outputted from pin 21 of the game chip. The composite video and sync is then fed to the RF modulator circuit, where it is heterodyned with either a channel 3 or channel 4 signal. This process takes place at diode CR6.

The RF signal mentioned above is obtained from transistor Q3 and its associated circuitry. Coil L3 is tuned to channel 4, while trimmer C20 places additional capacitance in the circuit producing a channel 3 signal. The output of the RF oscillator is fed to diode CR6, where it is modulated by the composite video signal.

At this point the RF signal, channel 3 or channel 4, is coupled to transformer T1. The secondary of T1 is connected to RF output jack J1, which provides a signal path for the signal through a coax cable to the TV receiver.

Start switch S1 is connected between pin 20 of the game chip and ground. When it is pressed, the ball is served to the player that missed last.

Audio signal exit pin 9 of the game chip, where they are fed to the base of AF amplifier Q1. The output of Q1 directly drives the speaker, which is located in the emitter circuit.

Player controls consist of RC networks connected between the 5V supply and pins 3, 4, 14, and 15. Each control is a 1M pot with a 1K connect in series to the 5V supply. Shunting the pots are 0.068 $\mu$F capacitors.

There are four power supply lines excluding chassis ground: +6V, +5V, +8V, and −3V. The first two supplies are derived from the four 1.5V D-cells, while the latter two are generated by rectifying the clock frequency in voltage doubler circuits. The clock frequency is fed through a portion of A1 (inverter). Once inverted, the AC signal is fed to two voltage doubler circuits. One of these is a negative voltage doubler and the other positive. These two power sources are used by the game chip only.

## CHANNEL FREQUENCY ADJUSTMENT

This procedure should only be performed when a proper display cannot be fine tuned on both channel 3 and 4. To make sure that the malfunction lies within the video game, connect the unit to another

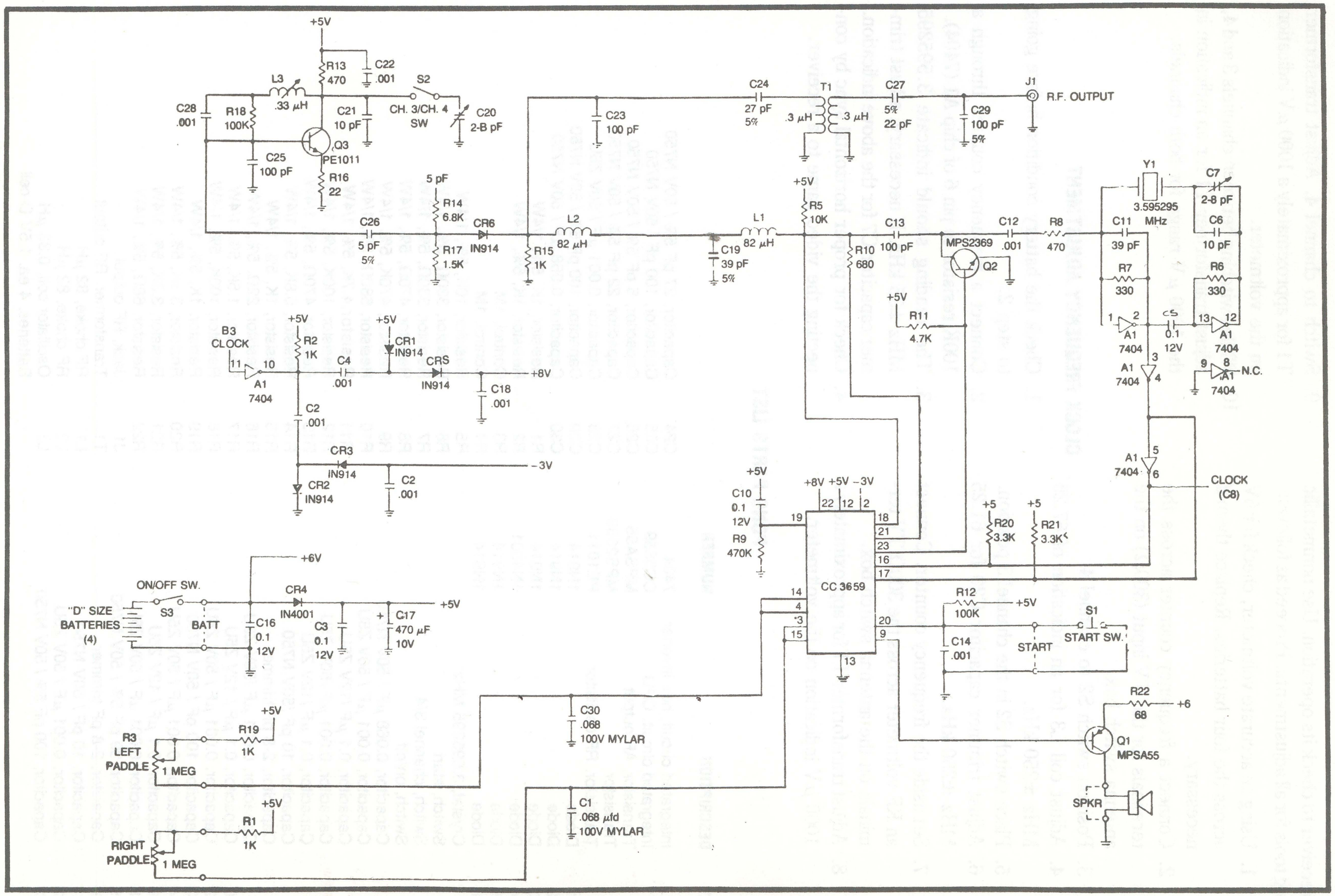



Fig. 8-1. Schematic diagram of Atari's Pong game.

TV receiver to check its operation. Use nonmetallic tuning tools for all adjustments. Proceed as follows:

1. Using an accurate voltmeter, check for 6V across the four batteries. Replace them if necessary.
2. Connect a frequency counter across the terminals for the TV input (300Ω) on the antenna switch box.
3. Position switch S2 to channel 4.
4. Adjust coil L3 for an indication of 67.25 MHz ±250 kHz.
5. Place switch S2 in the channel 3 position.
6. Adjust trimmer capacitor C20 for 61.25 MHz ±250 kHz.
7. Set aside the frequency counter. Connect an RF voltmeter across the 300Ω TV terminals on the antenna switch box.
8. Adjust transformer T1 for approximately a 1000 $\mu$V indication on the voltmeter.
9. Switch to channel 4. Adjust transformer T1 for approximately a 1000 $\mu$V indication on the voltmeter.
10. While switching between channels 3 and 4, adjust transformer T1 for an indication in the 1000 $\mu$V range for both channels.

## CLOCK FREQUENCY ADJUSTMENT

1. Check the battery condition before going to step 2.
2. Connect a frequency counter through a 100K resistor to pin 6 of chip A1 (7404).
3. The reading should indicate 3.595295 MHz ±35 kHz. If necessary, adjust trimmer capacitor C7 for the above indication.
4. Check for proper horizontal sync by connecting the video game to a receiver.

## PONG PARTS LIST

| PART | DESCRIPTION | NUMBER |
|---|---|---|
| A1 | Integrated circuit, hex inverter | 7404 |
| A2 | Integrated circuit, CPU | CC3659 |
| Q1 | Transistor, AF output | MPSA55 |
| Q2 | Transistor | MPS2369 |
| Q3 | Transistor, RF oscillator | PE1011 |
| CR1 | Diode | 1N914 |
| CR2 | Diode | 1N914 |
| CR3 | Diode | 1N914 |
| CR4 | Diode | 1N4001 |
| CR5 | Diode | 1N914 |
| CR6 | Diode | 1N914 |
| Y1 | Crystal, 3.595295 MHz | |
| S1 | Switch, start | |
| S2 | Switch, channel 3/4 | |
| S3 | Switch, on/off | |
| C1 | Capacitor, 0.068 $\mu$F / 50V N750 | |
| C2 | Capacitor, 0.001 $\mu$F / 50V Z5U | |
| C3 | Capacitor, 0.1 $\mu$F /12V Z5U | |
| C4 | Capacitor, 0.001 $\mu$F /50V Z5U | |
| C5 | Capacitor, 0.1 $\mu$F /12V Z5U | |
| C6 | Capacitor, 10 pF /50V N750 | |
| C7 | Capacitor, 2-8 pF trimmer | |
| C9 | Capacitor, 0.001 $\mu$F /50V Z5U | |
| C10 | Capacitor, 0.1 $\mu$F / 12V Z5U | |
| C12 | Capacitor, 0.001 $\mu$F / 50V Z5U | |
| C13 | Capacitor, 100 pF / 50V N750 | |
| C14 | Capacitor, 0.001 $\mu$F / 50V Z5U | |
| C16 | Capacitor, 0.1 $\mu$F / 12V Z5U | |
| C18 | Capacitor, 0.001 $\mu$F / 50V Z5U | |
| C19 | Capacitor, 39 pF 5% / 50V N750 | |
| C20 | Capacitor, 2-8 pF trimmer | |
| C21 | Capacitor, 10 pF / 50V N750 | |
| C22 | Capacitor, 0.001 $\mu$F / 50V Z5U | |
| C23 | Capacitor, 100 pF 5% / 50V N750 | |
| C24 | Capacitor, 27 pF 5% / 50V N750 | |
| C25 | Capacitor, 100 pF / 50V N750 | |
| C26 | Capacitor, 5 pF 5% / 50V N750 | |
| C27 | Capacitor, 22 pF 5% / 50V N750 | |
| C28 | Capacitor, 0.001 $\mu$F / 50V Z5U | |
| C29 | Capacitor, 100 pF 5% / 50V N750 | |
| C30 | Capacitor, 0.068 $\mu$F / 50V N750 | |
| R1 | Resistor, 1K, 5%, 1/4W | |
| R2 | Resistor, 1K, 5%, 1/4W | |
| R3 | Control, 1M | |
| R4 | Control, 1M | |
| R5 | Resistor, 10K, 5%, 1/4W | |
| R6 | Resistor, 330Ω, 5%, 1/4W | |
| R7 | Resistor, 330Ω, 5%, 1/4W | |
| R8 | Resistor, 470Ω, 5%, 1/4W | |
| R9 | Resistor, 470K, 5%, 1/4W | |
| R10 | Resistor, 680Ω, 5%, 1/4W | |
| R11 | Resistor,4.7K, 5%, 1/4W | |
| R12 | Resistor, 100K, 5%, 1/4W | |
| R13 | Resistor, 470Ω, 5%, 1/4W | |
| R14 | Resistor, 6.8K, 5%, 1/4W | |
| R15 | Resistor, 1K, 5%, 1/4W | |
| R16 | Resistor, 22Ω, 5%, 1/4W | |
| R17 | Resistor, 1.5K, 5%, 1/4W | |
| R18 | Resistor, 100K, 5%, 1/4W | |
| R19 | Resistor, 1K, 5%, 1/4W | |
| R20 | Resistor, 3.3K, 5%, 1/4W | |
| R21 | Resistor, 3.3K, 5%, 1/4W | |
| R22 | Resistor, 68Ω, 5%, 1/4W | |
| J1 | Jack, RF output | |
| T1 | Transformer, RF output | |
| L1 | RF choke, 82 $\mu$H | |
| L2 | RF choke, 82 $\mu$H | |
| L3 | Oscillator coil, 0.33 $\mu$H | |
| | Batteries, 4 ea. 1.5V D-cell | |

# CHAPTER 9

# MIDWAY HOME PINBALL GAMES

Although one might first think that these amusement devices are electromechanical machines, it is not true with today's pinball games. What was a maze of wires and switches has become the playground of the microprocessor.

This chapter deals with four pinball machines: 606-1000 (Fireball), 614-1000 (Evel Knievel), 614-2000 (Captain Fantastic or Elton John), and 614-3000 (Fireball II).

These games have been built with the owner in mind. Solid-state electronic circuitry and plastic encapsulated switches have been utilized extensively because of their high degree of dependability. This system makes the game virtually trouble free.

## OPERATION & FEATURES

1. Depress the start button, located on the front of the game, one time for each player. The number of participating players is indicated by lit areas in the player section of the score glass (1, 2, 3, 4).
2. After each ball is played the score unit will scan through each player's score and come up to rest on the next player light, located in the player section of the score glass.
3. The game is equipped with a memory unit. Each participant plays his own game. That is, any features or partial features scored by a player (top rollovers; targets 1, 2 or 3; or the extra ball lights) are only his. The partial feature is called over to the player's next ball and is reset only after the indicated bonus is collected.
4. All target and rollover switches are scored as indicated on the playfield. A ball passing through a top rollover switch scores 1000 points, turns out its light, and advances the bonus score 1000 points. When all top rollover switches are scored, a 24,000-point bonus is awarded, the top rollover lights are reset, and the lower outside extra ball lights are lit.
5. Hitting targets 1, 2, and 3 in any order advances the bonus score 2000 points and awards double when targets 1 and 2 are made. It awards triple when targets 1, 2, and 3 are made. The points are awarded after the ball leaves the play area.
6. An extra ball is awarded when the ball played passes over the lower-outside rollover switch while the extra-ball lights are lit. When the top rollover switches are made and the extra ball switch in the easy position (50K), scores of 50,000, 100,000, and 150,000 are awarded; if the switch is in the hard position (100K), scores of 100,000, 200,000, and 300,000 are awarded. Refer to Fig. 9-1 for the location of the easy/hard extra ball switch. Extra balls may be accumulated if more than one feature is scored and are indicated by the same-player-shoots-again light on the lower playfield.
7. The diagnostic switch is provided only for test purposes and must be in the play position for the game to operate. See Fig. 9-1.

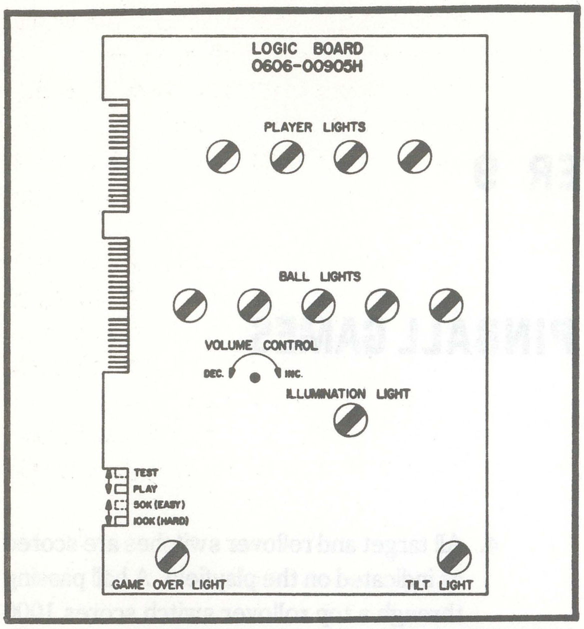



Fig. 9-1. Layout of logic board showing locations of 50K/100K switch and diagnostic test switch.

8. The volume control is located on the logic board. The volume can be varied by rotating the control as indicated in Fig. 9-1.
9. Shaking or pounding on the machine will result in a tilt. When the machine is tilted, all switches and bumpers are disabled and no bonus points are awarded. If an extra ball has been awarded previous to the tilt, the same player plays his extra ball.
10. There are five tones and seven songs played during different parts of a game. Tones and songs for the Evel Knievel game are listed below. Other games are similar.

- Tone 1. Sound associated with a score of 1000.
- Tone 2. Sound associated with a score of 500.
- Tone 3. Sound associated with a score of 100.
- Tone 4. Sound associated with a score of 50.
- Tone 5. Sound associated with multiple players at the start of the game.
- Beethoven's *Fifth Symphony* plays when the reset button is depressed.
- *William Tell Overture* plays when the top rollovers are made.
- *Zippideedooda* plays when a double bonus is made.
- *Notre Dame Fight Song* plays when a triple bonus is made.
- *We're in the Money* plays when an extra ball is awarded.
- *Funeral March* plays when the game is tilted.
- *The Party's Over* plays when the game is over.

An overall schematic diagram for the 614-1000 (Evel Knievel) and the 614-3000 (Fireball II) is shown in Fig. 9-2. The 606-1000 (Fireball) is similar. The schematic diagram for the 614-2000 (Captain Fantastic) is shown in Fig. 9-3. You'll notice that the power supply sections of these overall schematics are not detailed. They show only input/output lines and connections. Detailed schematics of the 0606-00906 and 0614-00912 power supplies are shown in Figs. 9-4 and 9-5.

In addition, certain driver stages on the overall schematics are not detailed. They are only coded to references such as A, B, L, or Q and enclosed in logic symbols representing inverters or buffers. Figures 9-6 and 9-7 illustrate the drivers used in all pinball games covered here. Also in the diagrams are tables listing the values of bias components used by the drivers.

## DIAGNOSTIC TEST

These games have a special feature incorporated in them. This is the diagnostic test. It is strongly believed that this test can be effectively utilized to identify a good logic board and game, and help focus the problem area on an improperly functioning game.

The test is started by switching the diagnostic switch on the logic board to the test position. It will test the logic, the program, the drivers, the score display, the switches, the solenoids and the lamps.

## 606-1000 & 614-1000/3000

When the diagnostic switch is placed in the test position, the following sequence of testing takes place:

1—Logic and program test. When the program is correct, the machine will show 600c on the score display. When the logic or

program is wrong the score display will show gibberish or be off.

2—Score display and its driver plus switches and their drivers. The machine will go through a scanning sequence from 000000 to 999999.

a. When a segment driver (lamp buffer) fails, the same segment on all digits will be permanently off or on.

b. When a digit driver fails, that digit will be permanently off or on.

c. When the score display fails, only one or more unrelated segments will be permanently off.

d. When a switch is stuck or a driver fails, it is shown in a code on the display when the test is finished. See Fig. 9-8 for a cross-reference of these codes. Any other number shown in the display indicates that there is more than one stuck switch. In this case, the displayed number is the sum of these stuck-switch codes. Examples of this condition are as follows:

| DISPLAY | SWITCHES |
|---|---|
| 00 00 11 | S-20 and S-1 |
| 04 00 05 | S-11, S-20, and S-9 |
| ⊔0 00 01 | S-20, S-13, and S-19 |
| 00⊏0⊔0 | S-6, S-14 (or S-15), S-8, and S-18 |

Switch locations are shown in Fig. 9-9.

3—The solenoids and drivers are activated in the following sequence:

a. Ball return

b. Left slingshot

c. Right slingshot (not used by 614-1000)

d. Left thumper bumper

e. Right thumper bumper

### 614-2000

The 50K/100K free ball switch must be in the 100K position. When the diagnostic switch is placed in the test position, the following sequence of testing takes place:

1—Logic and program test. When the program is correct, it will display 600d on the score readout. If it is wrong, the score display will be gibberish or be off.

2—Score display and its drivers plus the switches and their drivers.

a. The score display will go through a scanning sequence from 000000 to 999999.

b. When a segment driver (lamp buffer) fails, the same segment in all digits will either be permanently off or on.

c. When a digit driver fails, that digit will be permanently off or on.

d. When the score display itself fails, one or more unrelated segments will be permanently off.

e. With the 50K/100K switch in the 100K position, 000000 will be shown on the score display. A stuck switch will not be indicated unless it was stuck prior to the test being started. See Fig. 9-8 for a cross-reference of stuck switch codes. Any other number in the score display indicates that there is more than one stuck switch. In this case, the displayed number is the sum of these stuck-switch codes. Examples of this condition are as follows:

| DISPLAY | SWITCHES |
|---|---|
| 00 00 11 | S-20 and S-1 |
| 04 00 05 | S-11, S-20, and S-9 |
| ⊔0 00 01 | S-20, S-13, and S-19 |
| 00⊏0⊔0 | S-6, S-14 (or S-15), S-8, and S-18 |

Switch locations are shown in Fig. 9-9.

f. With the 50K/100K switch in the 100K position, the diagnostic test will continue until the test/play switch is moved into the play position.

g. During the diagnostic test the lights on the game will alternate in two groups as listed below:
*Group 1*—P-1, P-2, B-1, B-2, L-1, L-2, L-4, L-10, L-11, L-14, L-15, L-16, L-17, L-18*, and L-22.
*Group 2*—P-3, P-4, B-3, B-4, B-5, L-3, L-6, L-7, L-8, L-9, L-12, L-13, L-18*, L-19, L-20, L-21, and game over.

*—L-18 illuminated in both groups.

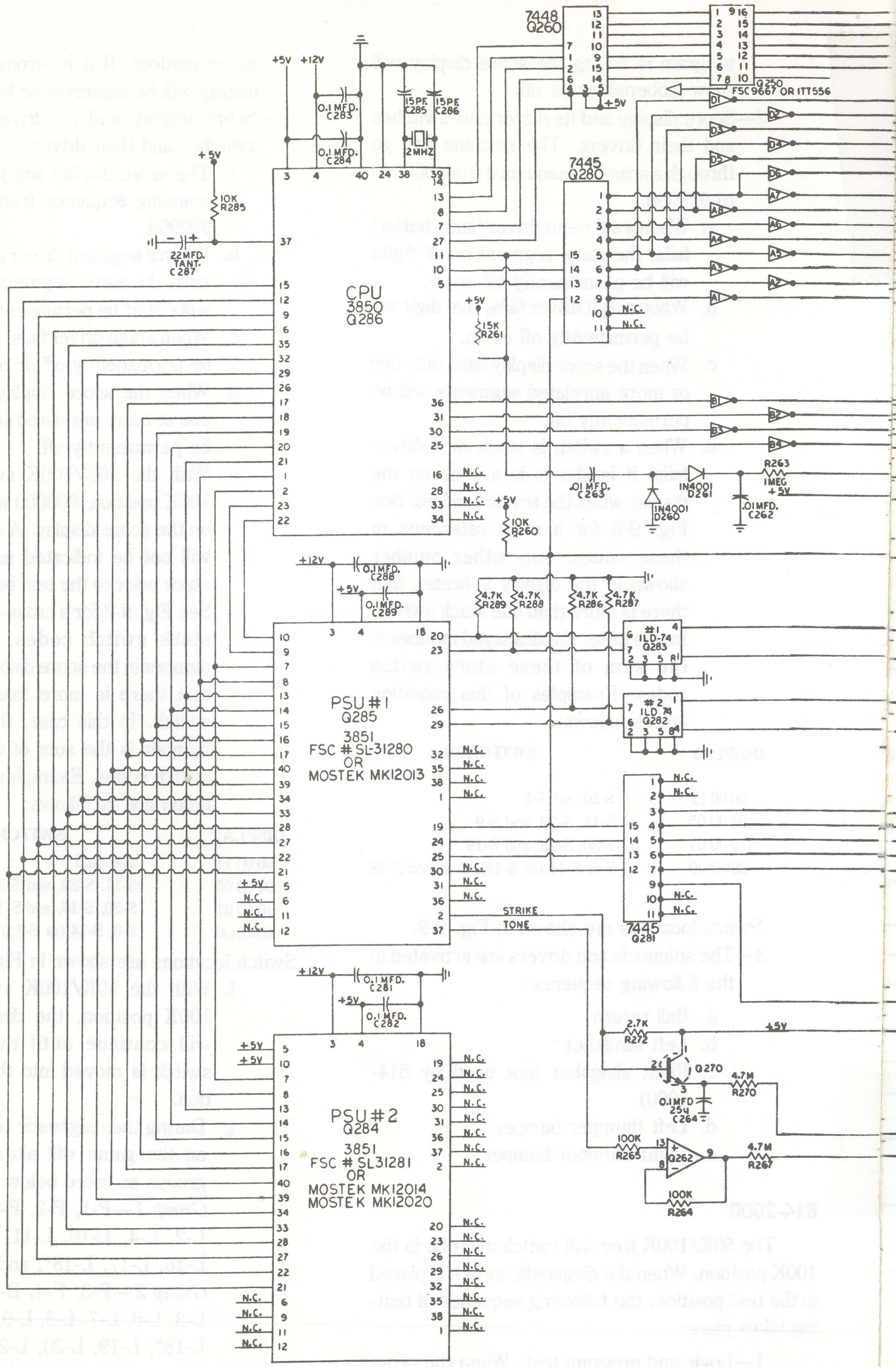


Fig. 9-2. Overall schematic diagram of the 614-1000 (Evel Knievel) and 614-3000 (Fireball II). The 606-1000 (Fireball I) is similar. See Fig. 9-4 for a detailed schematic of the 606-00906 power supply and Fig. 9-6 for driver stage information (sheet 1 of 4).



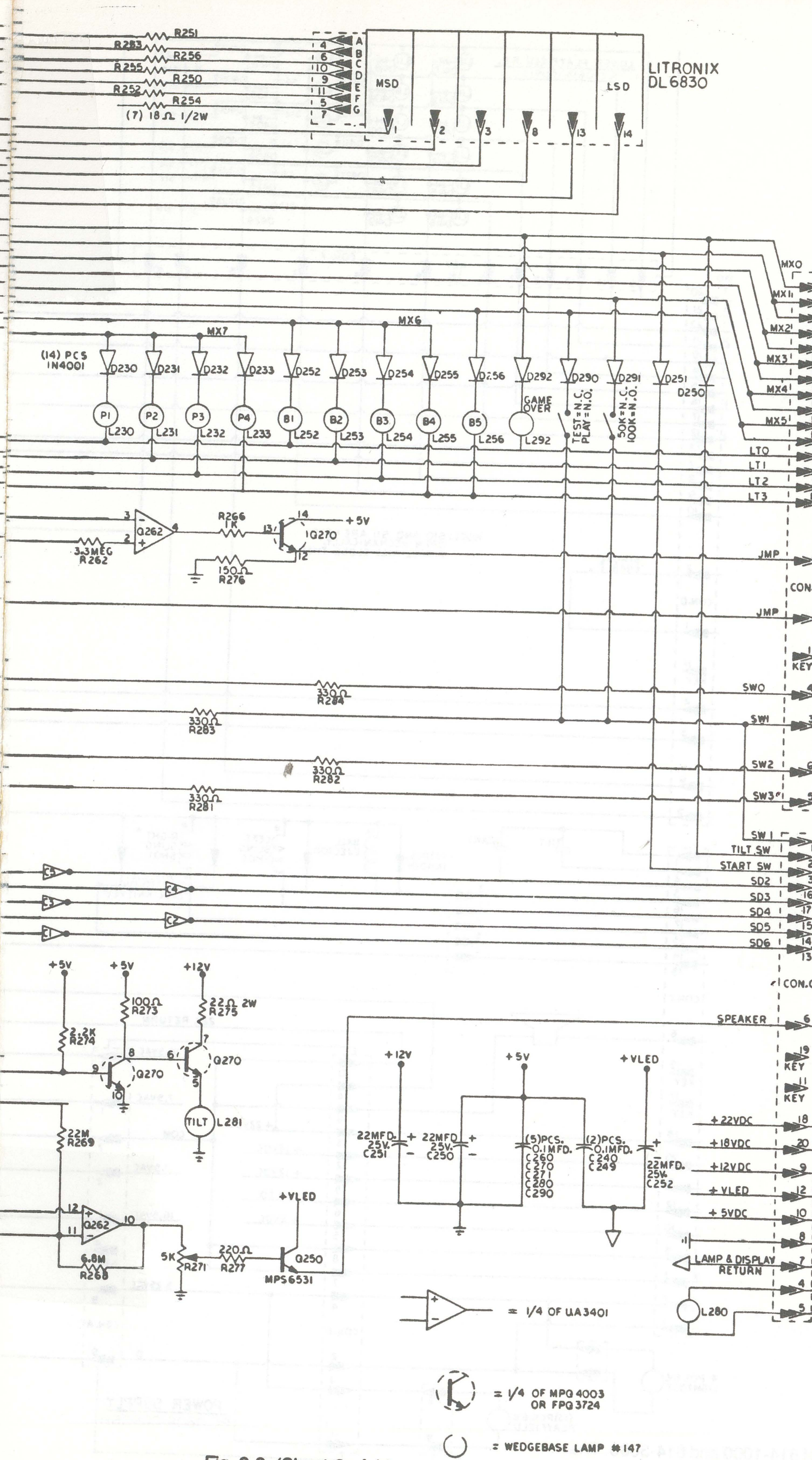


Fig. 9-2. (Sheet 2 of 4.)

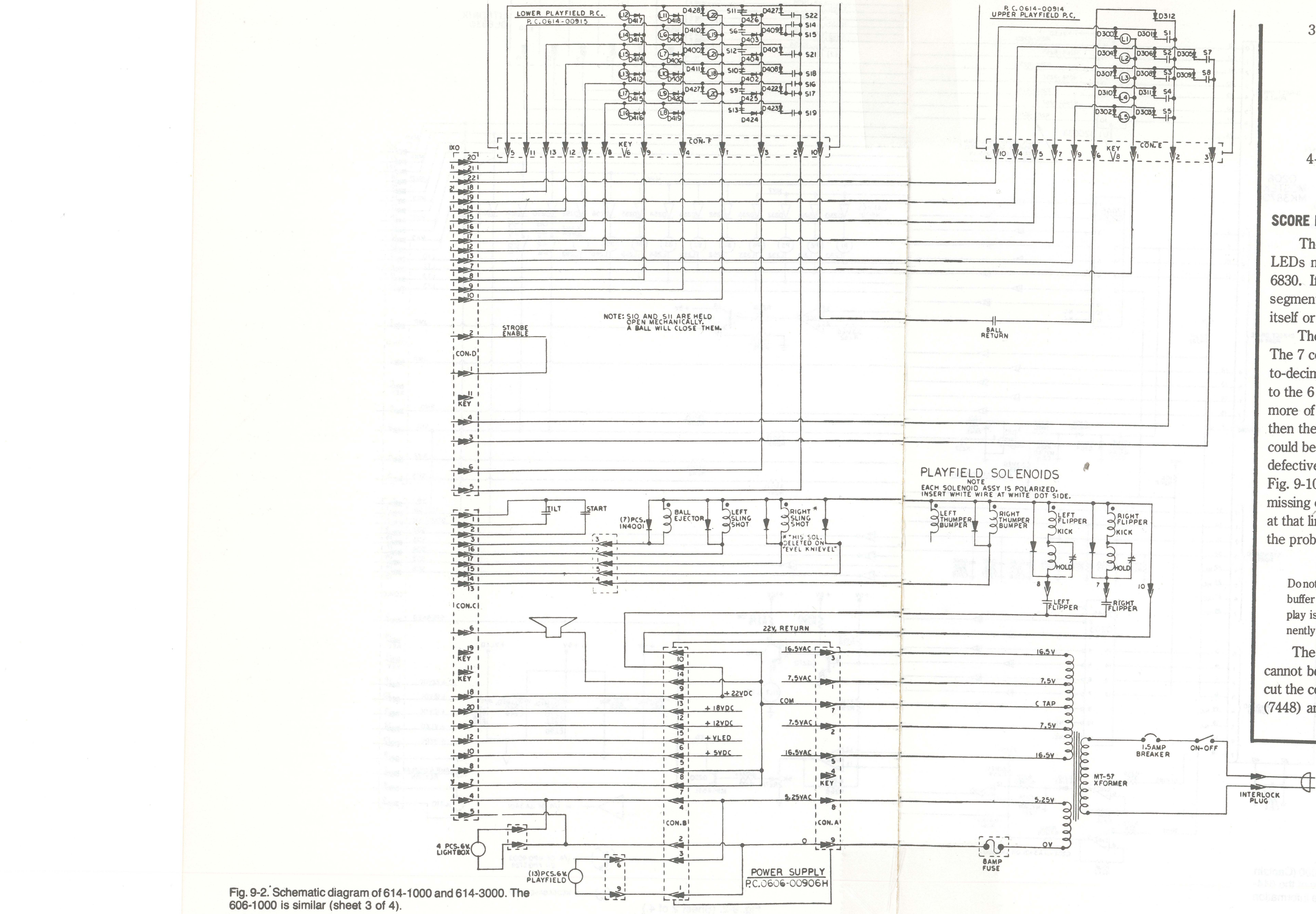



Fig. 9-2. Schematic diagram of 614-1000 and 614-3000. The 606-1000 is similar (sheet 3 of 4).

Fig. 9-2. (Sheet 4 of 4.)

3—The solenoids and their respective drivers are activated in the following sequence:
   a. Ball return
   b. Left slingshot
   c. Right slingshot
   d. Left thumper bumper
   e. Right thumper bumper

4—One light out during the test indicates bulb failure. Four or eight lights out indicates driver failure.

## SCORE DISPLAY

The game score is displayed using an array of LEDs mounted in one package, the Litronix DL-6830. If the numerals on the display miss some segments, it could be either due to a bad display itself or wrong information being fed into it.

The display can be viewed as a 7 × 6 matrix. The 7 corresponding to the 7 outputs of the BCD-to-decimal decoders (7448) and the 6 corresponding to the 6 display drivers (D1 through D6). If one or more of the numerals are completely blanked out, then the corresponding driver transistor (TIP115) could be suspected and should be replaced if found defective. A typical display driver output is shown in Fig. 9-10. If one particular segment of the display is missing on all the numerals (e.g., segment a), then at that line should be followed backwards to isolate the problem.

### CAUTION

Do not try to ground the outputs of the lamp buffer (FSC 9667) to determine if the display is good or bad, as this could permanently damage the display.

The best way to check for a good display, if it cannot be determined by the diagnostic test, is to cut the connection pin 3 (lamp test) on the decoder (7448) and ground it. This should light up all the

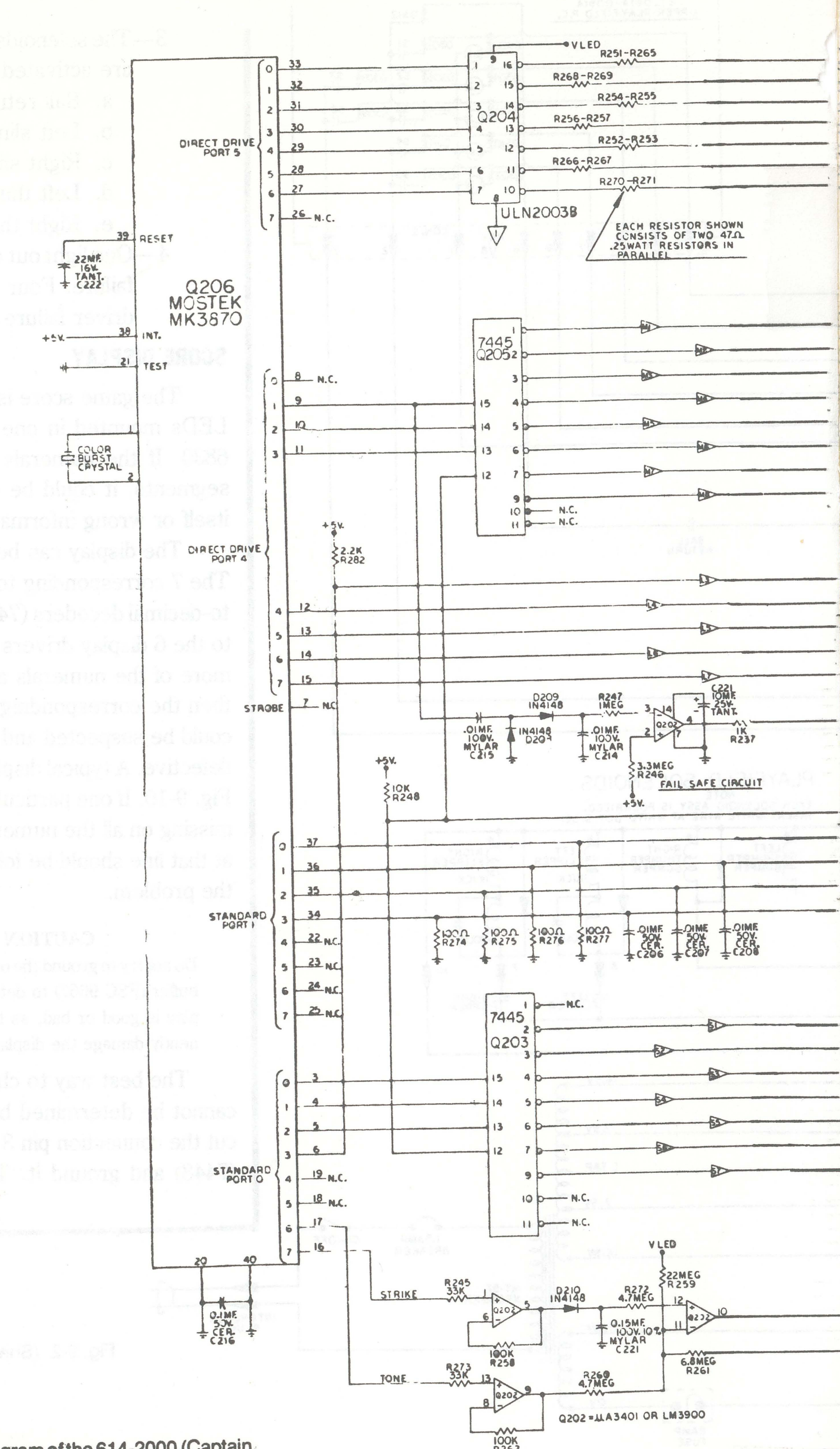



Fig. 9-3. Overall schematic diagram of the 614-2000 (Captain Fantastic). See Fig. 9-5 for a detailed schematic of the 614-00912 power supply and Fig. 9-7 for driver stage information (sheet 1 of 4).



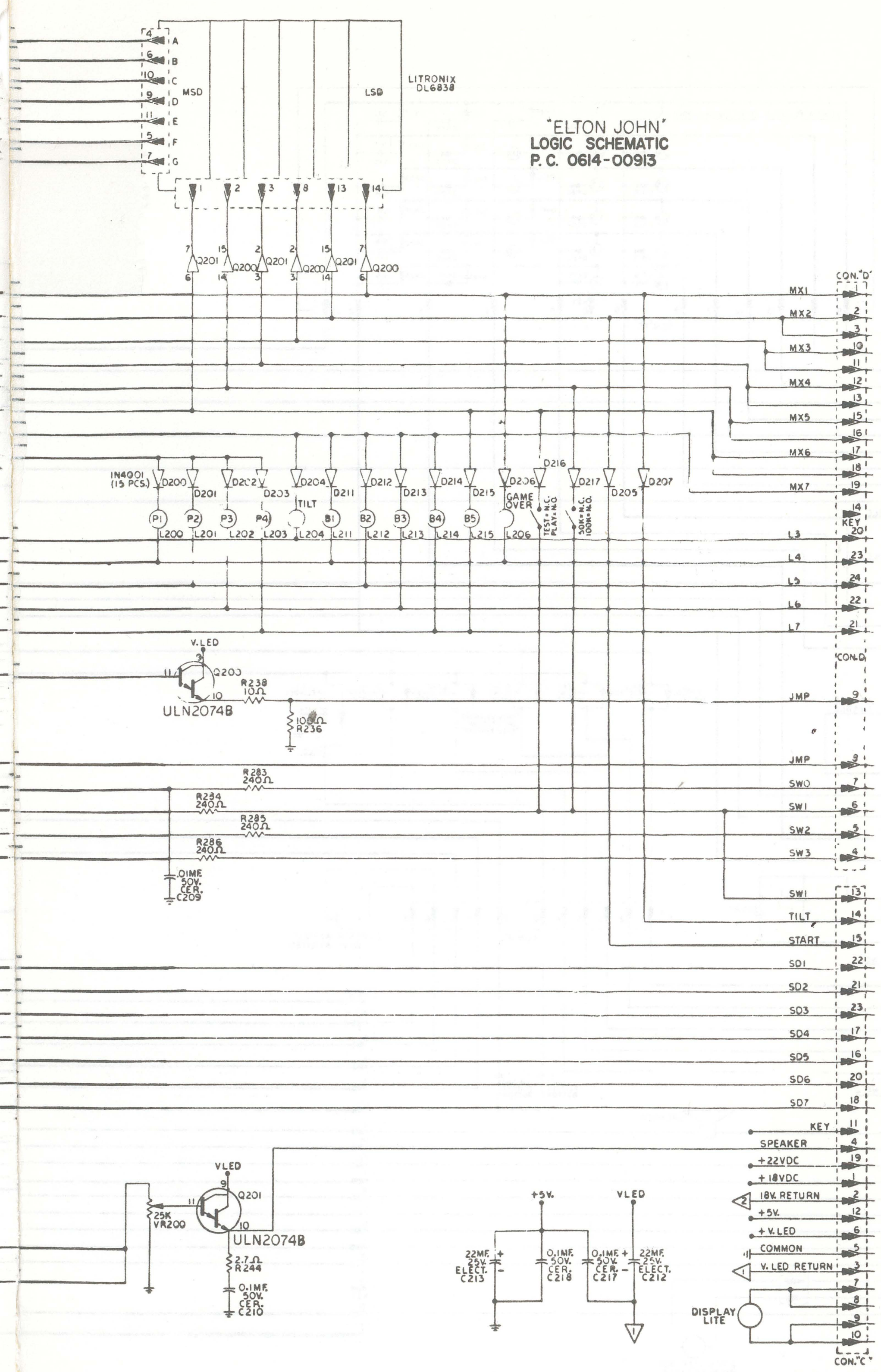



Fig. 9-3. (Sheet 2 of 4.)

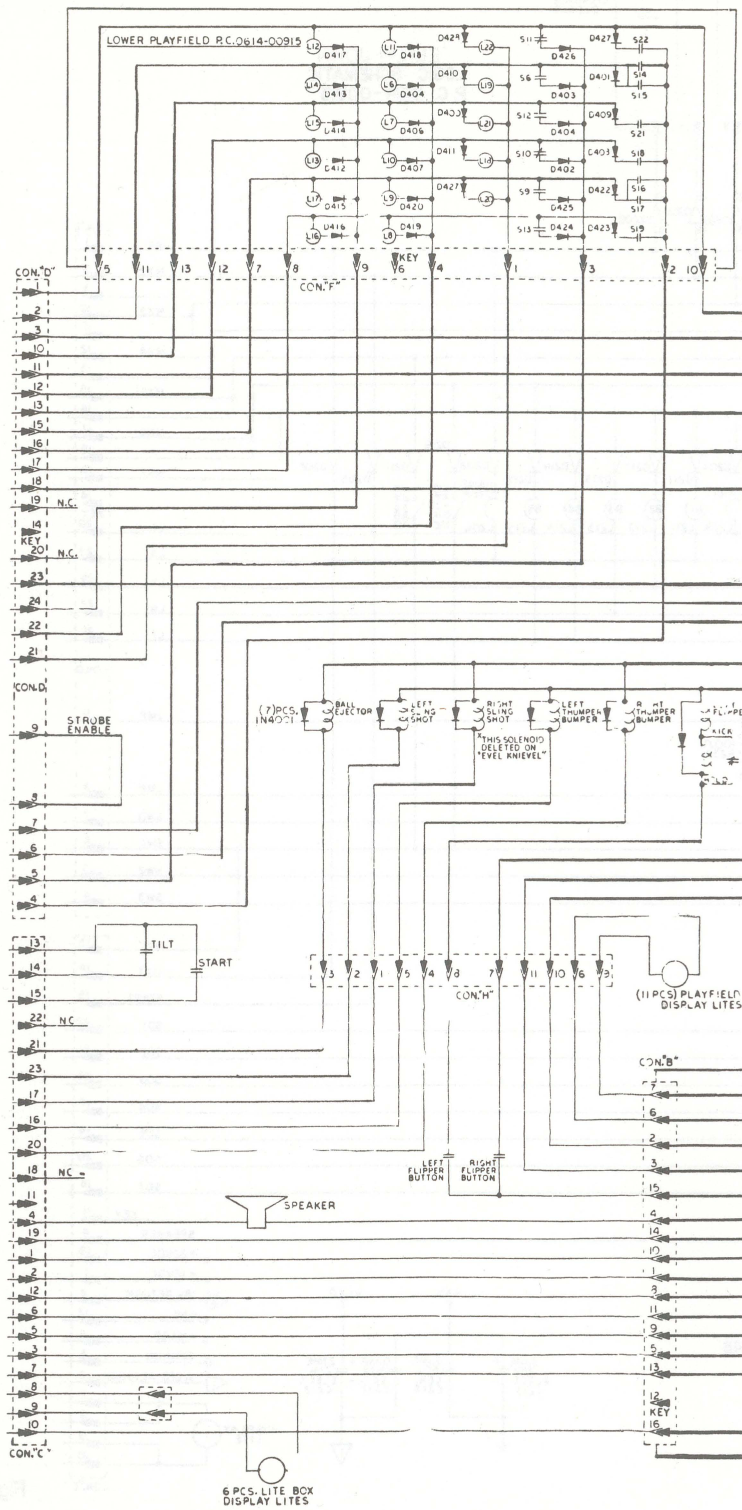


Fig. 9-3. Schematic diagram of the 614-2000 (sheet 3 of 4).

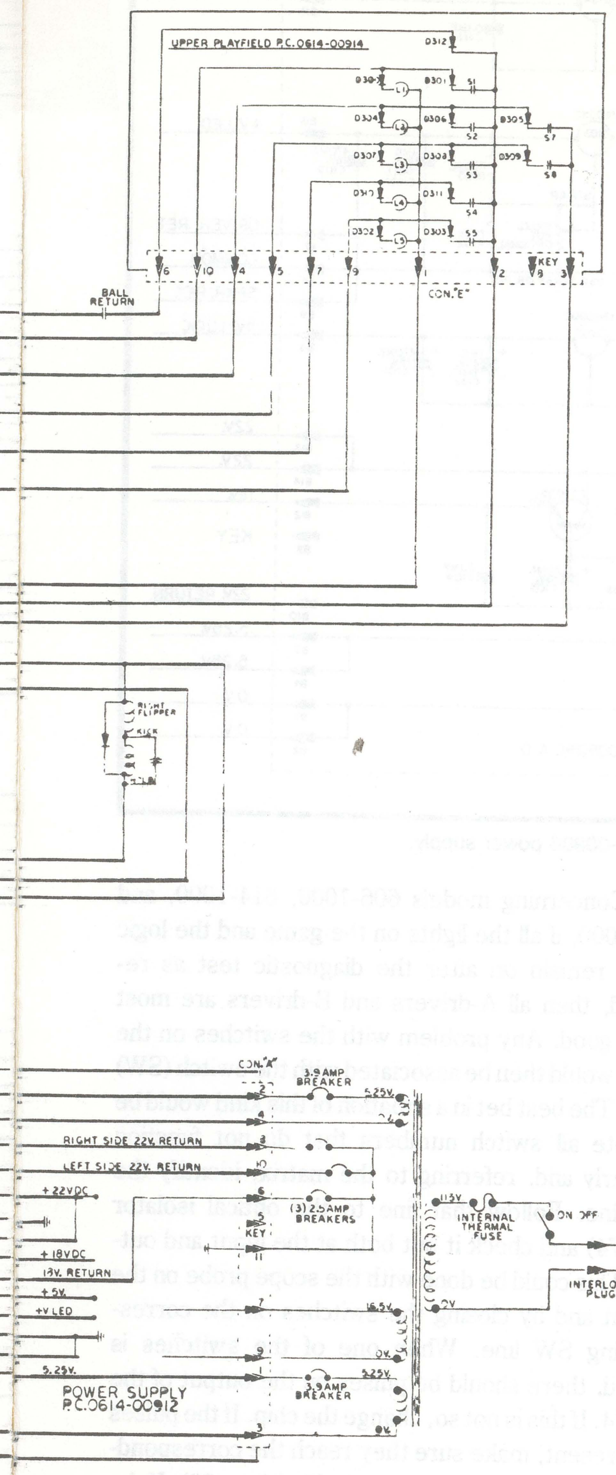


Fig. 9-3. (Sheet 4 of 4.)

segments of the display. If one or more segments blank out on some numerals while being lit on others, then the display is bad and should be replaced. If all the numerals miss the same segment, then that line stould be followed backwards to isolate the problem. This could happen due to a bad lamp buffer (FSC 9667) or a broken 18Ω resistor. In some instances, the decoder (7448) could also cause such problems, but it is usually not so.

The display of the 614-2000 can be viewed also as a 7 × 6 matrix, the 7 corresponding to the 7 outputs of the CPU-to-decimal decoder, ULN2003B, and the 6 corresponding to the outputs of the Q-drivers in the ULN2074Bs. Each of the ULN2074Bs drives three numerals. If any of the numerals are missing, the output of the respective ULN2074B should be checked. A typical output is shown in Fig. 9-11. If one particular segment of the display is missing on all the numerals (e.g., segment a), then that line should be followed backwards to isolate the problem. This could happen due to a bad ULN2003B or one or more broken 47Ω resistors. In some instances the CPU could also cause such problems, but it is not usually so.

## MATRIX SECTION

All the lights (except the tilt light and the 5.25V AC lights) and all the switches located on the logic board and upper and lower playfields are included in this section.

The lights form an 8 × 4 matrix comprised of 8 multiplex (MX) lines and 4 light (LT) lines. The switches can similarly be viewed as a 6 × 4 matrix comprised of 6 multiplex (MX) lines and 4 switch (SW) lines. The MX lines are driven by the A-drivers (TIP115), the LT lines are driven by the B-drivers (TIP110), and the SW lines feed into the optical isolators (ILD74).

For the 614-2000, the MX lines are driven by the M-drivers (TIP125) and the LT lines are driven by the L-drivers (TIP110). The SW lines are fed into the CPU.

As can be seen from Fig. 9-12, the A-drivers (all models except 614-2000) control 4 lights each and the B-drivers 8 each. Therefore, anytime there is a problem with the lights, the best procedure would be to note the light numbers of missing lights, then check the matrix in Fig. 9-12 for the driver

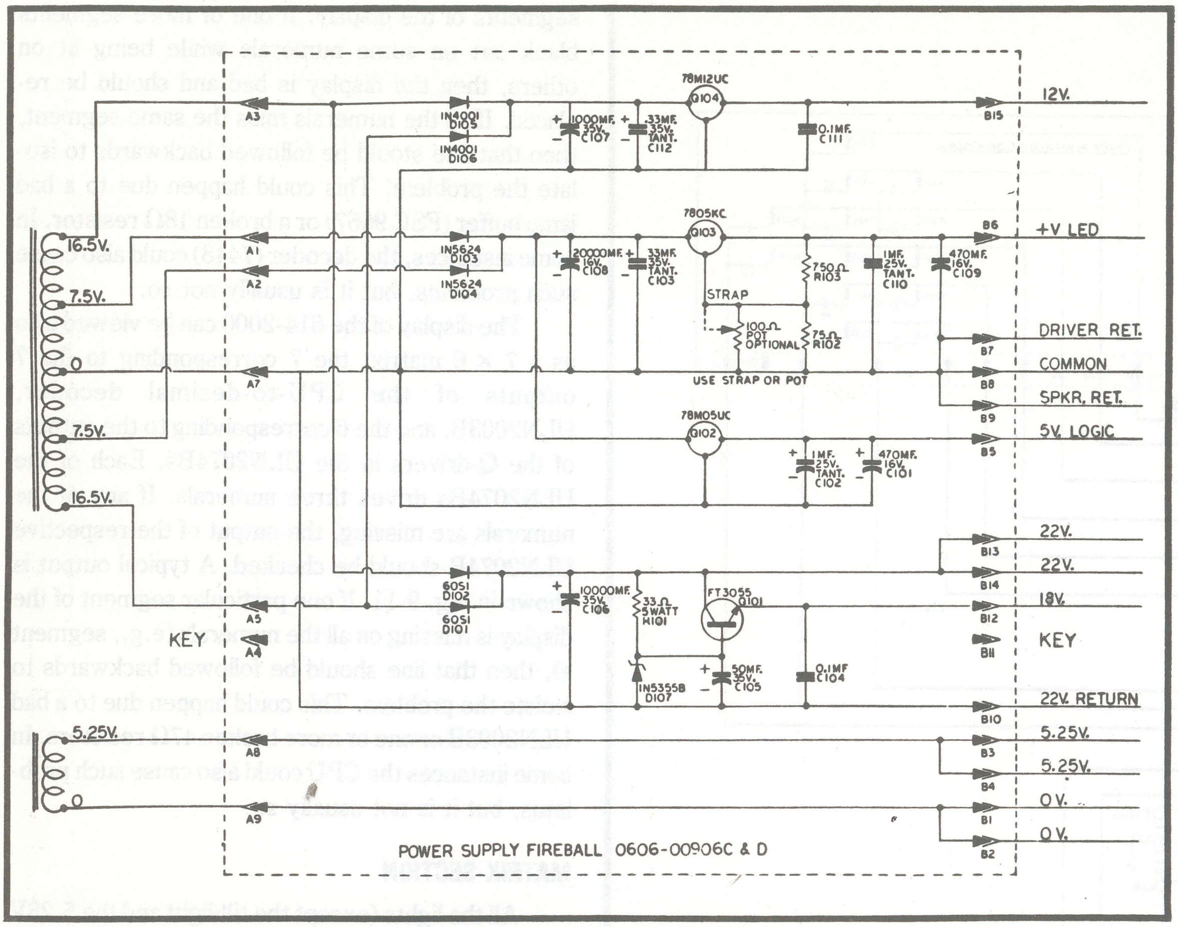



**Fig. 9-4. Schematic diagram of the 0606-00906 power supply.**

responsible. For example, if all 4 lights for the players (P1–P4) do not light up, then possibly driver A1 could be bad. A typical A-driver output is shown in Fig. 9-13. However, if light P1, light B1, and the game-over light on the logic board, together with lights L5, L4, L3, L2, and L1, do not light up, then possibly driver B1 is bad.

As can also be seen from Fig. 9-12 the M-drivers (model 614-2000) control 4 lights each and the L-drivers 8 lights each. Therefore, anytime there is a problem with the lights, the best procedure would be to note the light numbers of the missing lights, then check the matrix to find the responsible driver. For example, if all 4 lights for the players (P1–P4) do not light up, then possibly driver M8 could be bad. A typical M-driver output is shown in Fig. 9-13. However, if lights P1, B1, and the game-over light on the logic board, together with lights L1, L2, L3, L4, and L5, do not light up, then possibly driver L4 is bad.

Concerning models 606-1000, 614-1000, and 614-3000, if all the lights on the game and the logic board remain on after the diagnostic test as required, then all A-drivers and B-drivers are most likely good. Any problem with the switches on the game would then be associated with the switch (SW) lines. The best bet in a situation of this kind would be to note all switch numbers that do not function properly and, referring to the matrix, identify the SW line. Follow that line to the optical isolator (ILD74) and check it out both at the input and output. This could be done with the scope probe on the output and by closing the switches on the corresponding SW line. When one of the switches is closed, there should be pulses on the output of the ILD74. If this is not so, change the chip. If the pulses are present, make sure they reach the corresponding pin on the PSU #1 (pins 20, 23, 26, or 29). If the pulse is present at the input to the PSU and still the switch does not do its job, then change PSU #1.

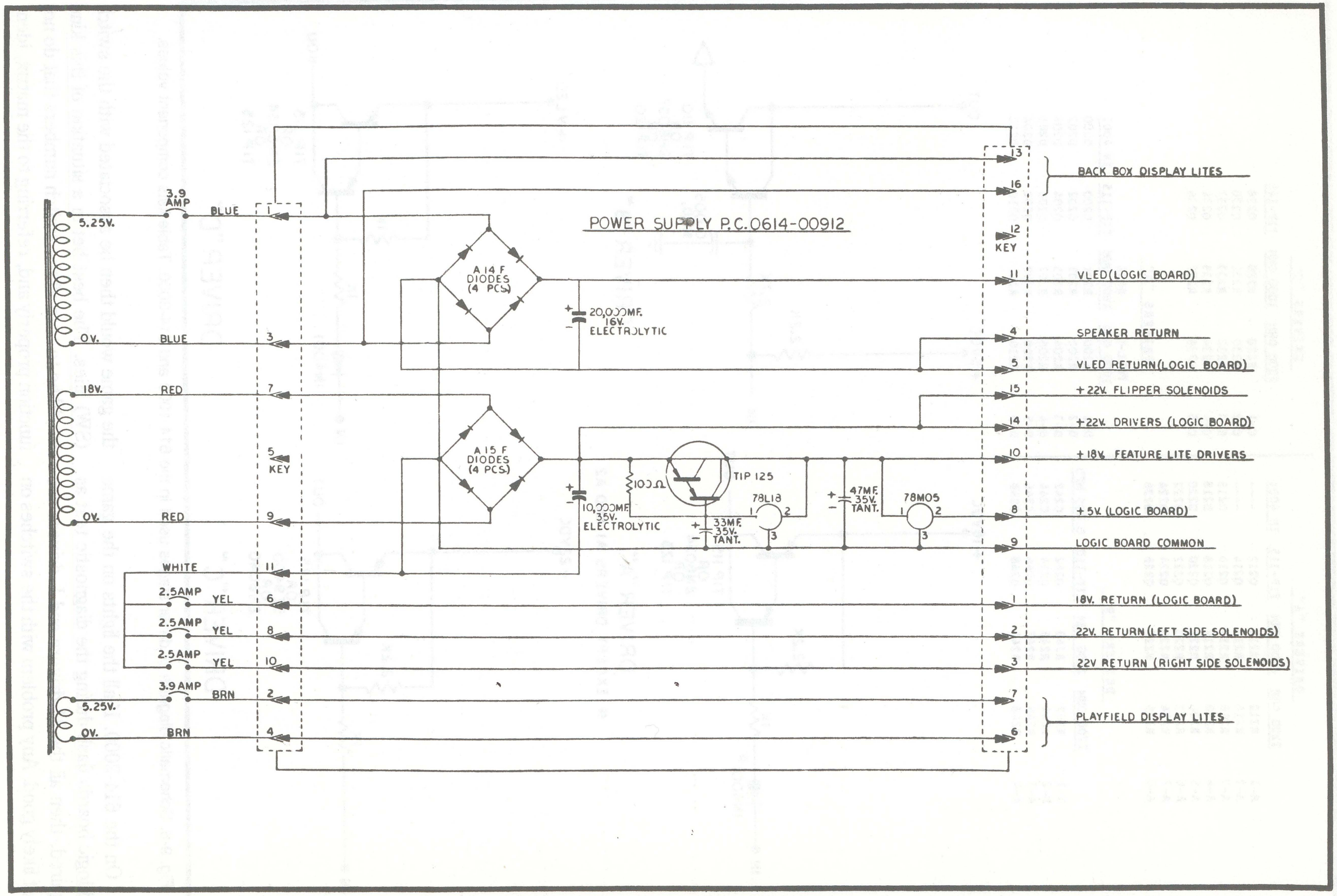



**Fig. 9-5. Schematic diagram of the 0614-00912 power supply.**

**DRIVERS "A"**

| | 2200 OHM | 1000 OHM | TIP-115 | IN 4001 |
|---|---|---|---|---|
| A-1 | R212 | R213 | Q212 | ---- |
| A-2 | R214 | R215 | Q214 | ---- |
| A-3 | R216 | R217 | Q216 | D216 |
| A-4 | R218 | R219 | Q218 | D218 |
| A-5 | R220 | R221 | Q220 | D220 |
| A-6 | R222 | R223 | Q222 | D222 |
| A-7 | R224 | R225 | Q224 | D224 |
| A-8 | R226 | R227 | Q226 | D226 |

**DRIVERS "B"**

| | 2700 OHM | 2200 OHM | TIP-110 | 0.005 MFD |
|---|---|---|---|---|
| B-1 | R242 | R243 | Q242 | C242 |
| B-2 | R244 | R245 | Q244 | C244 |
| B-3 | R246 | R247 | Q246 | C246 |
| B-4 | R248 | R249 | Q248 | C248 |

**DRIVERS "C"**

| | 2200 OHM | 1000 OHM | TIP-145 |
|---|---|---|---|
| C-1 | R228 | R229 | Q228 |
| C-2 | R230 | R231 | Q230 |
| C-3 | R232 | R233 | Q232 |
| C-4 | R234 | R235 | Q234 |
| C-5 | R236 | R237 | Q236 |

**DRIVERS "D"**

| | PULL-UP 1000 OHM | BASE 1000 OHM | TIP-115 | IN 4001 |
|---|---|---|---|---|
| D-1 | R200 | R201 | Q200 | D200 |
| D-2 | R202 | R203 | Q202 | D202 |
| D-3 | R204 | R205 | Q204 | D204 |
| D-4 | R206 | R207 | Q206 | D206 |
| D-5 | R208 | R209 | Q208 | D208 |
| D-6 | R210 | R211 | Q210 | D210 |

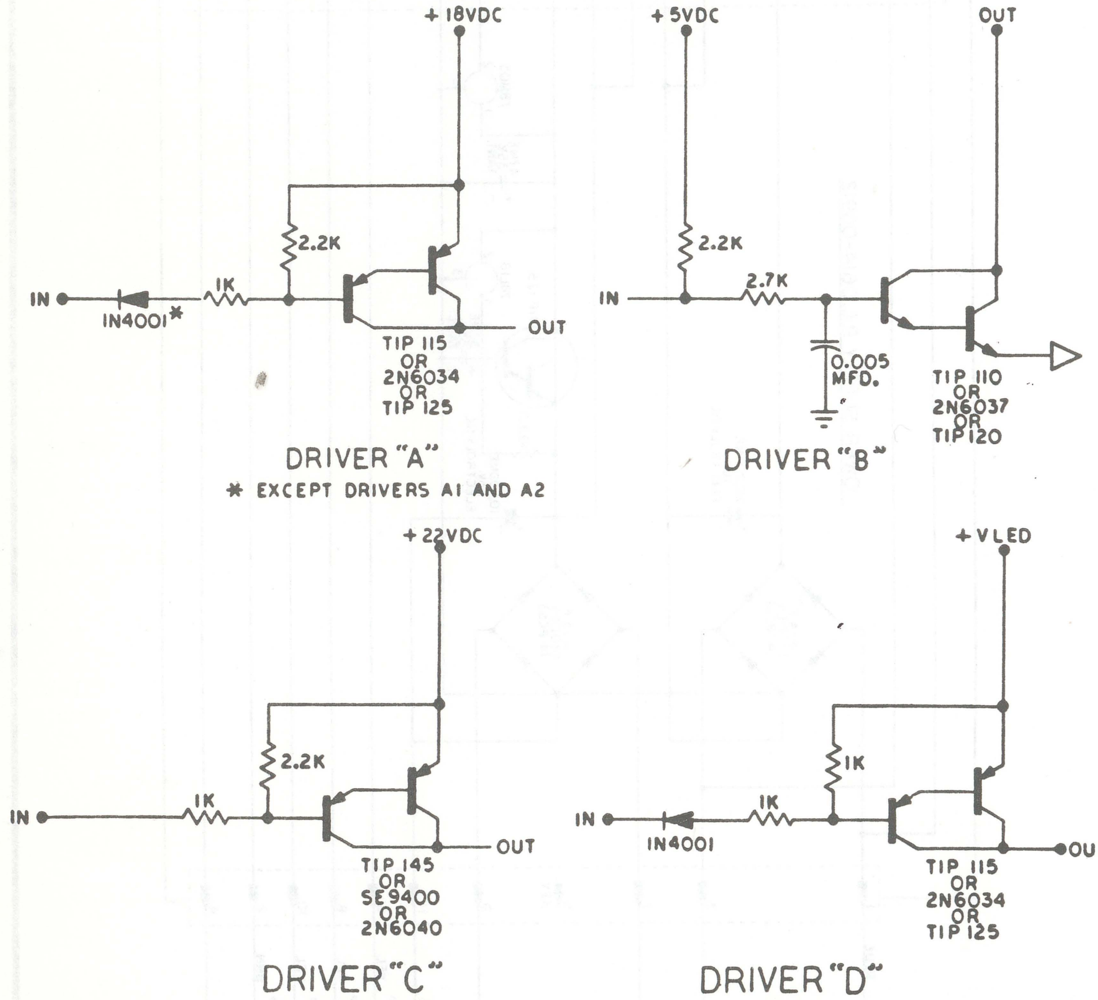



Fig. 9-6. Schematic diagram of driver stages used in the 614-1000 and 614-3000. Table lists component values.

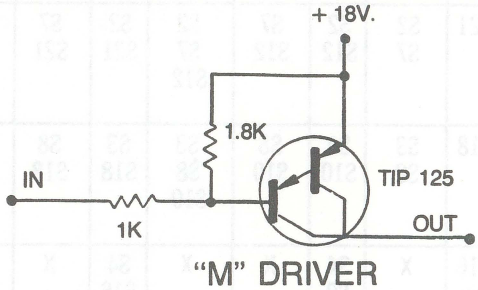
On the 614-2000. If all the lights on the game and logic boards flash during the diagnostic test as required, then all the M-drivers and L-drivers are most likely good. Any problem with the switches on the game would then be associated with the switch (SW) lines. The best bet in a situation of this kind would be to note all the switch numbers that do not function properly and, referring to the matrix, iden-

tify the SW line. Follow that line to the respective 240Ω resistor. Check carefully for a broken resistor or capacitor (0.01 μF) in this section. There should be a pulse on both sides of the resistor every time one of the switches on that switch line is closed. If the pulses are present, make sure that they reach the CPU. If they reach the CPU, check the outputs of the CPU at pins 9, 10, 11, 12, 13, and 14. If these are not present change the CPU.

## SOLENOID SECTION

This section can be easily checked by performing the diagnostic test. On performing this test, all five of the solenoids controlled by the logic board should be energized in the following order:

1. Ball return
2. Left slingshot (not used in 614-1000)
3. Right slingshot




| TRANSISTOR OR I.C. | BASE RES, | BIAS RES. OR CAP |
|---|---|---|
| M-1 | R222 | R221 |
| M-2 | R212 | R211 |
| M-3 | R220 | R219 |
| M-4 | R210 | R209 |
| M-5 | R218 | R217 |
| M-6 | R208 | R207 |
| M-7 | R206 | R205 |
| M-8 | R216 | R215 |
| | | |
| L-3 | R204 | C204 |
| L-4 | R200 | C200 |
| L-5 | R201 | C201 |
| L-6 | R202 | C202 |
| L-7 | R203 | C203 |
| | | |
| S-1 | R232 | R233 |
| S-2 | R224 | R225 |
| S-3 | R213 | R214 |
| S-4 | R280 | R281 |
| S-5 | R279 | R279 |
| S-6 | R249 | R250 |
| S-7 | R263 | R264 |
| | | |
| Q200-3 | R227 | R235 |
| Q200-6 | R226 | R234 |
| Q200-14 | R229 | R228 |
| Q201-3 | R231 | R240 |
| Q201-6 | R230 | R239 |
| Q201-14 | R237 | R241 |

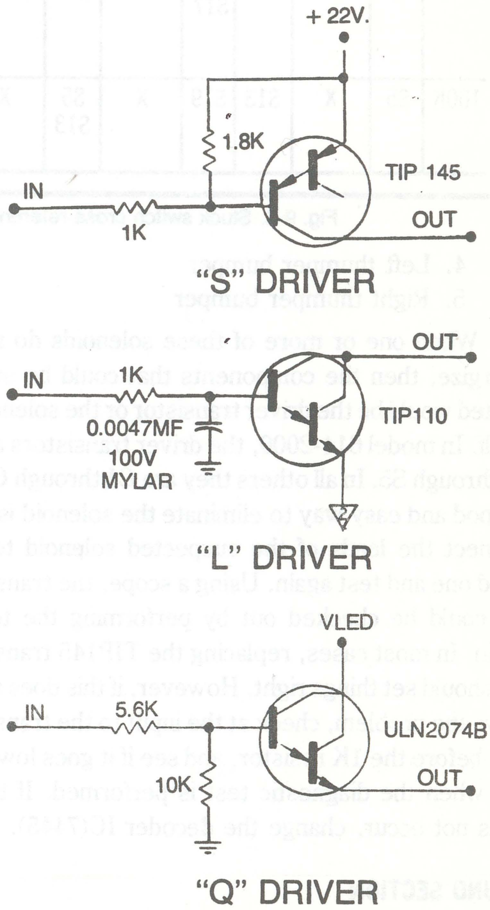



Fig. 9-7. Schematic diagram of driver stages used in the 614-2000. Table lists component values.

| LOCATION ON DISPLAY / READ OUT ON DISPLAY | 1 | 2 | 4 | 8 | 3 | 5 | 6 | 7 | 9 | ⊏ | ⊐ | ⊔ | ⊑ | t | b̸ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S20 | TILT | S11 | S22 | S20 TILT | S20 S11 | TILT S11 | S20 TILT S11 | S20 S22 | TILT S22 | S20 TILT S22 | S11 S22 | S20 S11 S22 | TILT S11 S22 | S20 TILT S11 S22 |
| 10 | S1 | START | S6 | S14 or S15 | S1 START | S1 S6 | START S6 | S1 START S6 | S1 S14 or S15 | START S14 or S15 | S1 START S14 or S15 | S6 S14 or S15 | S1 S6 S14 or S15 | START S6 S14 or S15 | S1 START S6 S14 or S15 |
| 100 | S2 | S7 | S12 | S21 | S2 S7 | S2 S12 | S7 S12 | S2 S7 S12 | S2 S21 | S7 S21 | S2 S7 S21 | S12 S21 | S2 S12 S21 | S7 S12 S21 | S2 S7 S12 S21 |
| 1K | S3 | S8 | S10 | S18 | S3 S8 | S3 S10 | S8 S10 | S3 S8 S10 | S3 S18 | S8 S18 | S3 S8 S18 | S10 S18 | S3 S10 S18 | S8 S10 S18 | S3 S8 S10 S18 |
| 10K | S4 | 50K | S9 | S16 or S17 | X | S4 S9 | X | X | S4 S16 or S17 | X | X | S9 S16 or S17 | S4 S9 S16 or S17 | X | X |
| 100K | S5 | X | S13 | S19 | X | S5 S13 | X | X | S5 S19 | X | X | S13 S19 | S5 S13 S19 | X | X |

Fig. 9-8. Stuck switch cross-reference diagram. See Fig. 9-9 for switch locations.

4. Left thumper bumper
5. Right thumper bumper

When one or more of these solenoids do not energize, then the components that could be suspected would be the driver transistor or the solenoid itself. In model 614-2000, the driver transistors are S1 through S5. In all others they are C1 through C5. A good and easy way to eliminate the solenoid is to connect the leads of the suspected solenoid to a good one and test again. Using a scope, the transistor could be checked out by performing the test again. In most cases, replacing the TIP145 transistor should set things right. However, if this does not solve the problem, check at the input to the transistor, before the 1K resistor, and see if it goes low or not when the diagnostic test is performed. If this does not occur, change the decoder IC(7445).

## SOUND SECTION

The sound section of the logic board is simple and straightforward. As can be seen from the schematic (Fig. 9-2) it is comprised of (1) PSU #1, (2) transistor array Q270 (FPQ3724), (3) op amp Q262 ($\mu$A3401 or LM3900), and transistor Q250 (MPS6531).

The frequency of the sound signal is varied internally in PSU #1 as required and is outputted at pin 37 of PSU #1 as TONE. The strike is what makes the sound audible. In other words, when pin 2 of PSU #1 goes high, there will be a sound signal at pin 10 of op amp Q262.

If the logic board loses its sound, the first place to check would be pins 37 and 2 of PSU #1. Turn the power switch on and put the game in the 1-player, first-ball mode by pushing the start switch once. There should be a square wave at pin 37 as shown in Fig. 9-14.

Now every time one of the switches on the playfield is closed, pin 2 of PSU #1 should go high momentarily. If this checks out, check pin 3 of transistor array Q270 (FPQ3724). It should be noted here that the 0.1 $\mu$F (Z5U) capacitor is very critical

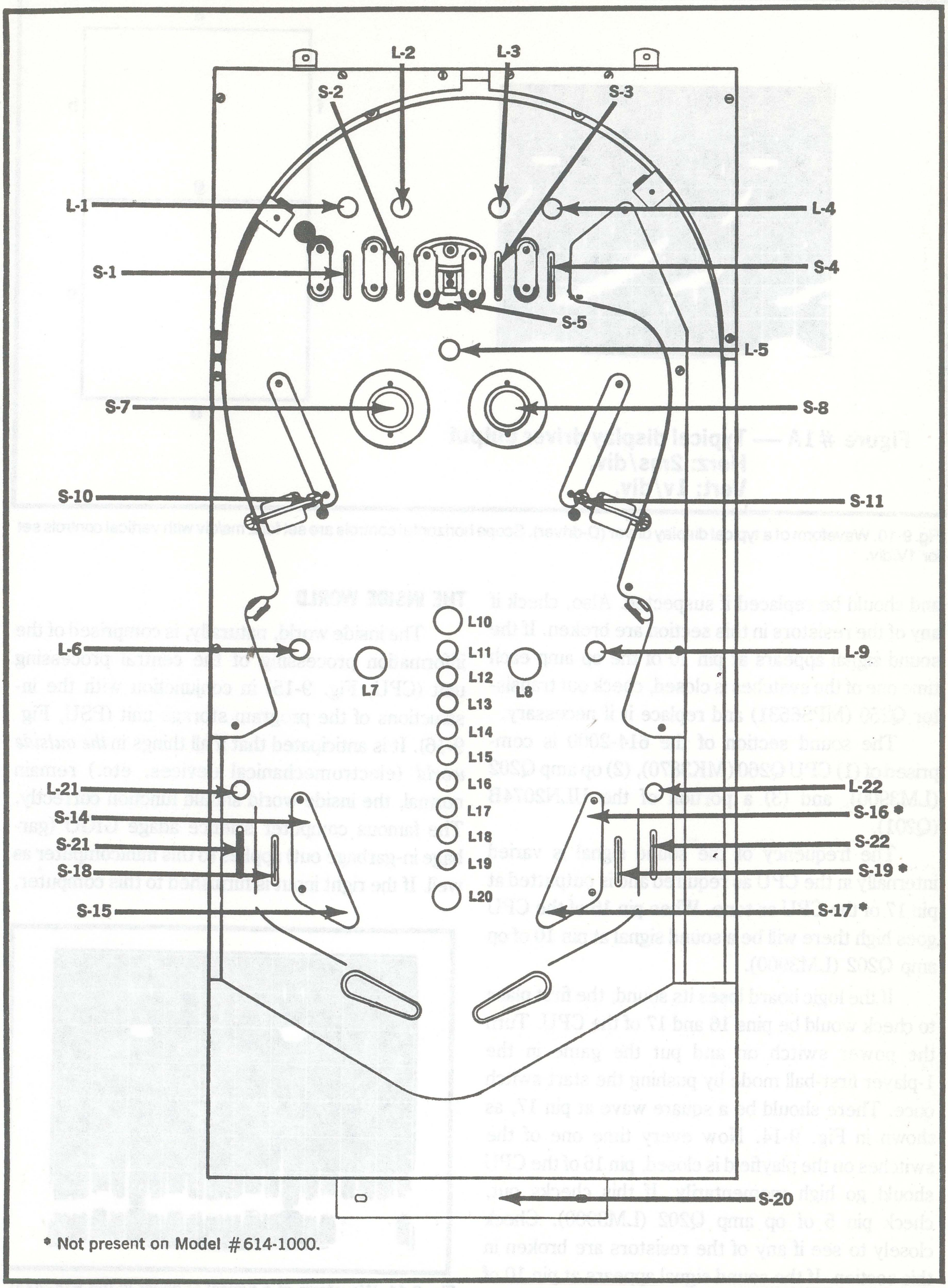



Fig. 9-9. Locations of switches and lamps. The playfield contains eight rollover switches (S1, S2, S3, S4, S18, S19, S21, and S22), six sling shot and side rubber switches (S12 through S17), three target switches (S5, S6, and S9), two thumper bumper switches (S7 and S8), one ball return switch (S20), and two spinner target switches (S10 and S11).

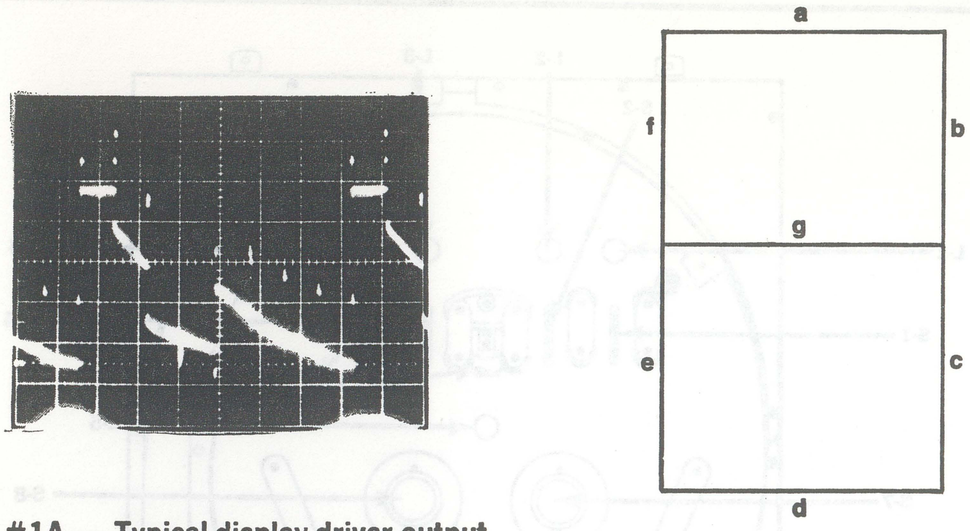



**Figure #1A — Typical display driver output**
**Horz: 2ms/div.**
**Vert: 1v/div.**

Fig. 9-10. Waveform of a typical display driver (D-driver). Scope horizontal controls are set for 2 ms/div with vertical controls set for 1V/div.

and should be replaced if suspected. Also, check if any of the resistors in this section are broken. If the sound signal appears at pin 10 of the op amp each time one of the switches is closed, check out transistor Q250 (MPS6531) and replace it if necessary.

The sound section of the 614-2000 is comprised of (1) CPU Q260 (MK3870), (2) op amp Q202 (LM3900), and (3) a portion of the ULN2074B (Q201).

The frequency of the sound signal is varied internally in the CPU as required and is outputted at pin 17 of the CPU as tone. When pin 16 of the CPU goes high there will be a sound signal at pin 10 of op amp Q202 (LM3900).

If the logic board loses its sound, the first place to check would be pins 16 and 17 of the CPU. Turn the power switch on and put the game in the 1-player first-ball mode by pushing the start switch once. There should be a square wave at pin 17, as shown in Fig. 9-14. Now every time one of the switches on the playfield is closed, pin 16 of the CPU should go high momentarily. If this checks out, check pin 5 of op amp Q202 (LM3900). Check closely to see if any of the resistors are broken in this section. If the sound signal appears at pin 10 of the op amp, check out Q201 (ULN2074B). Replace it if necessary.

## THE INSIDE WORLD

The inside world, naturally, is comprised of the information processing of the central processing unit (CPU, Fig. 9-15) in conjunction with the instructions of the program storage unit (PSU, Fig. 9-16). It is anticipated that if all things in *the outside world* (electromechanical devices, etc.) remain normal, the inside world should function correctly. The famous computer science adage GIGO (garbage in-garbage out) applies to this minicomputer as well. If the right input is furnished to this computer,

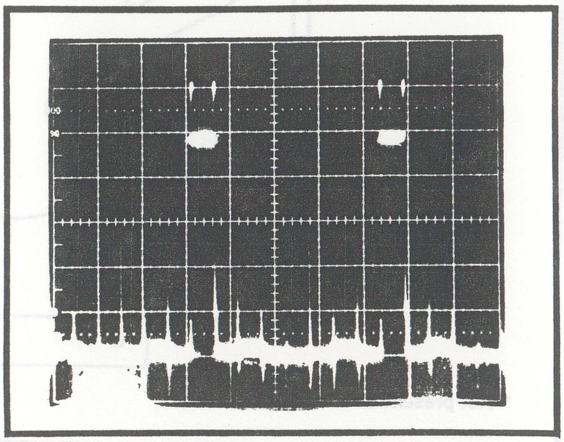


Fig. 9-11. Waveform of a typical Q-driver in the 614-2000. Scope controls are 2 ms/div for the horizontal and 1V/div for the vertical.

there is no reason why the right output should not be obtained.

A quick and easy way to check if the CPU and PSUs are functioning properly would be to perform the diagnostic test. If the display shows the characters 600c at the beginning of the test as it is supposed to, then it is confirmed that the CPU and PSUs are linked and functioning correctly.

If the display does not read 600c at the beginning of the test, that is, if the score display shows

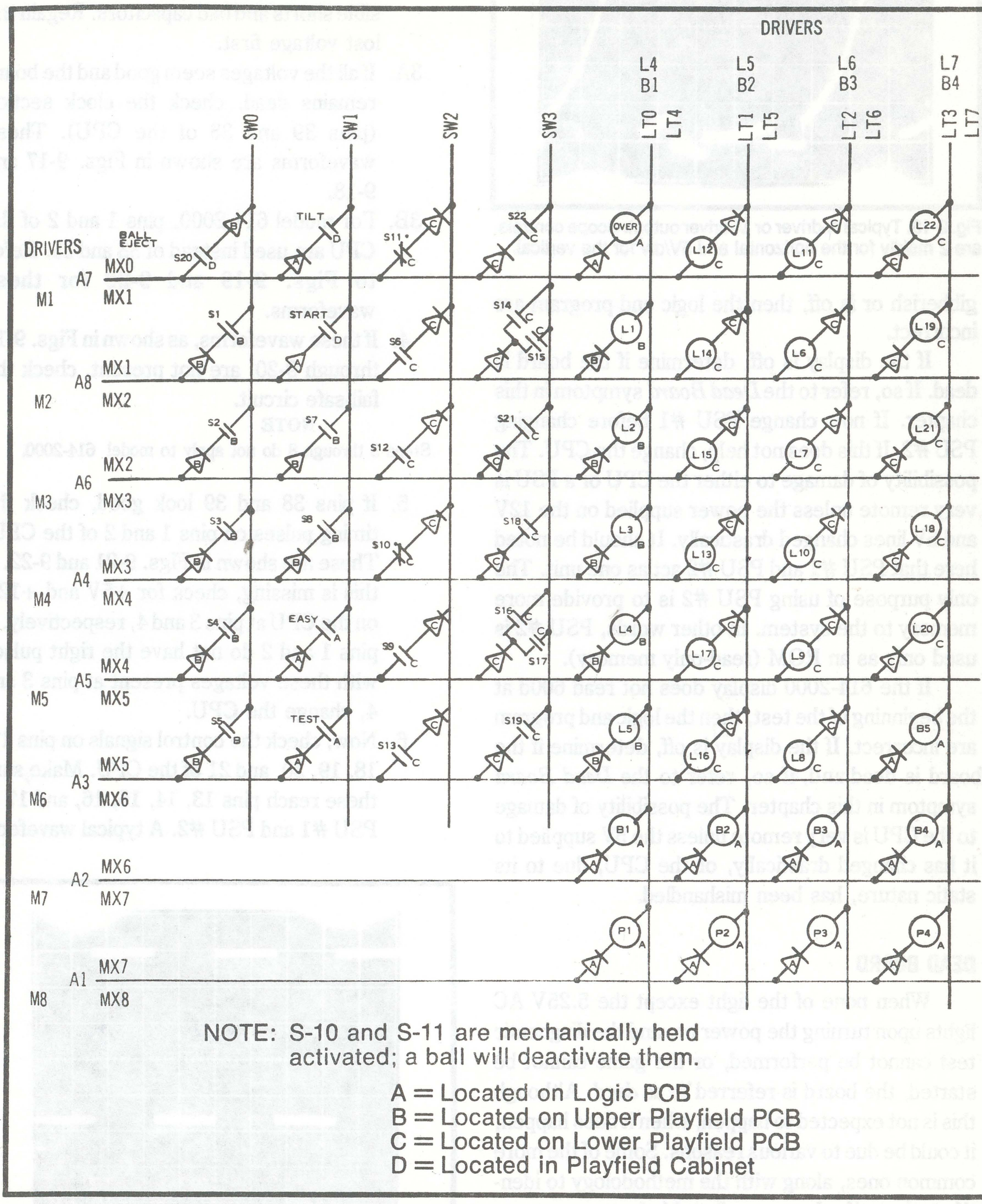



Fig. 9-12. The matrix. Data concerning the 614-2000 (Captain Fantastic) is shown in italics. To determine which lights driver A1 (614-1000 and 614-3000) controls, follow the horizontal plane, where driver A1 is located, across the figure. Lights P1 through P4 are controlled by driver A1. For the 614-2000, driver M8 controls the same set of lights, P1 through P4.

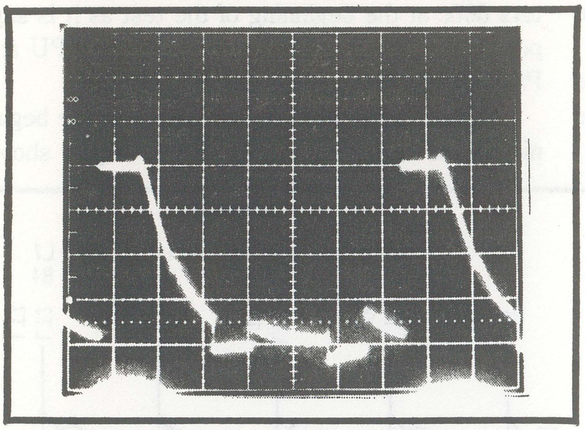


Fig. 9-13. Typical A-driver or M-driver output. Scope controls are 2 ms/div for the horizontal and 5V/div for the vertical.

gibberish or is off, then the logic and program are incorrect.

If the display is off, determine if the board is dead. If so, refer to the *Dead Board* symptom in this chapter. If not, change PSU #1 before changing PSU #2. If this does not help, change the CPU. The possibility of damage to either the CPU or a PSU is very remote unless the power supplied on the 12V and 5V lines changed drastically. It should be noted here that PSU #1 and PSU #2 act as one unit. The only purpose of using PSU #2 is to provide more memory to the system. In other words, PSU #2 is used only as an ROM (read-only memory).

If the 614-2000 display does not read 600d at the beginning of the test, then the logic and program are incorrect. If the display is off, determine if the board is dead and, if so, refer to the *Dead Board* symptom in this chapter. The possibility of damage to the CPU is very remote unless the 5V supplied to it has changed drastically, or the CPU, due to its static nature, has been mishandled.

## DEAD BOARD

When none of the light except the 5.25V AC lights upon turning the power on, and the diagnostic test cannot be performed, or the game cannot be started, the board is referred to as *dead*. Although this is not expected to happen, when it does happen, it could be due to various reasons. Some of the more common ones, along with the methodology to identify and rectify them, are listed below:

1. Check out the power supply. If another one is handy, replace the power supply.
2. Check all the voltages: 22V, 18V, 12V (not in 614-2000), +5V and VLED (5 to 6V) on the logic board. If any of these voltages are missing and it is found that the power supply is not responsible for it, check for possible shorts and bad capacitors. Regain the lost voltage first.

3A. If all the voltages seem good and the board remains dead, check the clock section (pins 39 and 38 of the CPU). These waveforms are shown in Figs. 9-17 and 9-18.

3B. For model 614-2000, pins 1 and 2 of the CPU are used instead of 38 and 39. Refer to Figs. 9-19 and 9-20 for these waveforms.

4. If these waveforms, as shown in Figs. 9-17 through 9-20, are not present, check the fail-safe circuit.

NOTE

Steps 5 through 8 do not apply to model 614-2000.

5. If pins 38 and 39 look good, check the timing pulses on pins 1 and 2 of the CPU. These are shown in Figs. 9-21 and 9-22. If this is missing, check for +5V and +12V on the CPU at pins 3 and 4, respectively. If pins 1 and 2 do not have the right pulses with these voltages present at pins 3 and 4, change the CPU.
6. Now, check the control signals on pins 17, 18, 19, 20, and 21 of the CPU. Make sure these reach pins 13, 14, 15, 16, and 17 of PSU #1 and PSU #2. A typical waveform

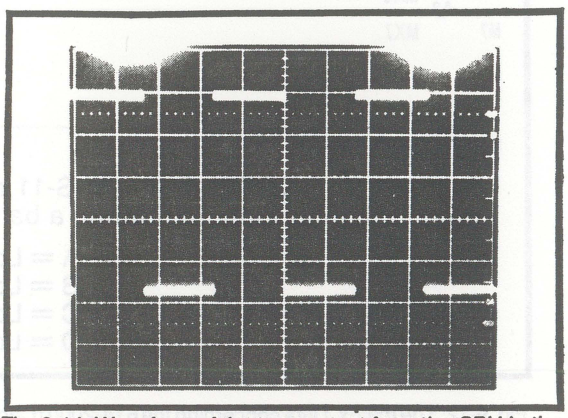
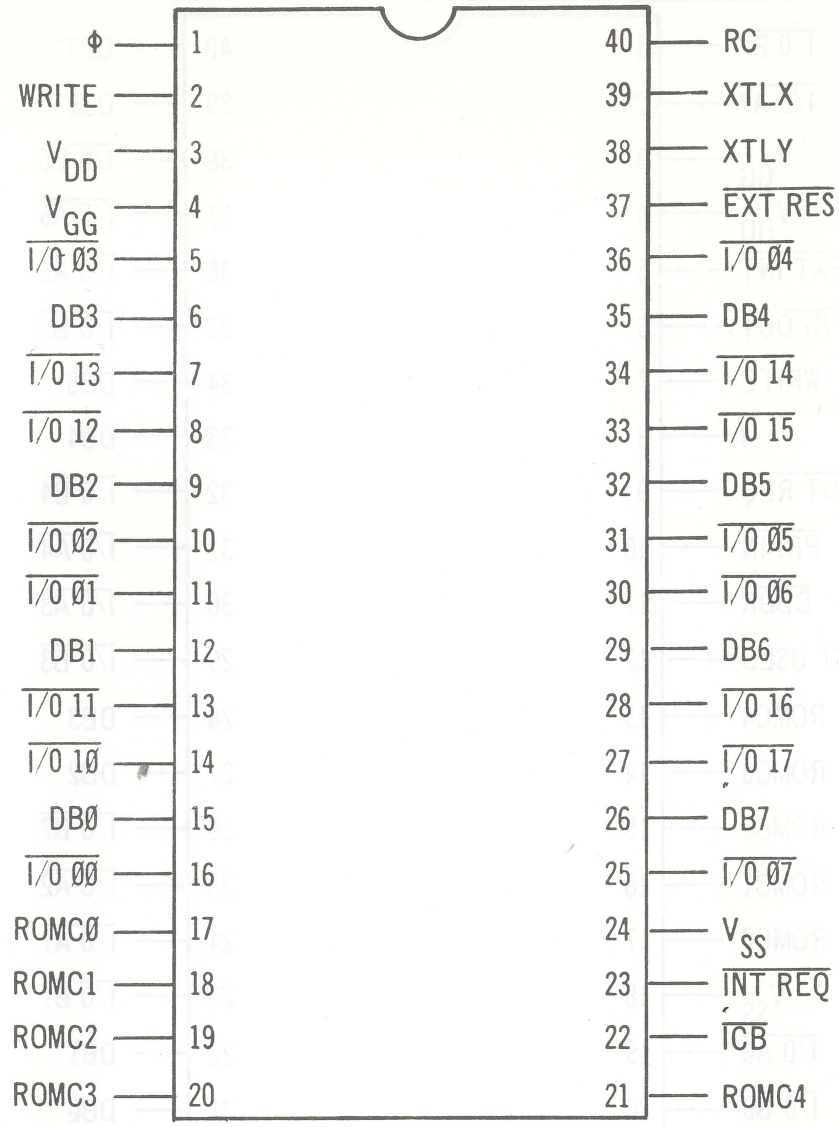
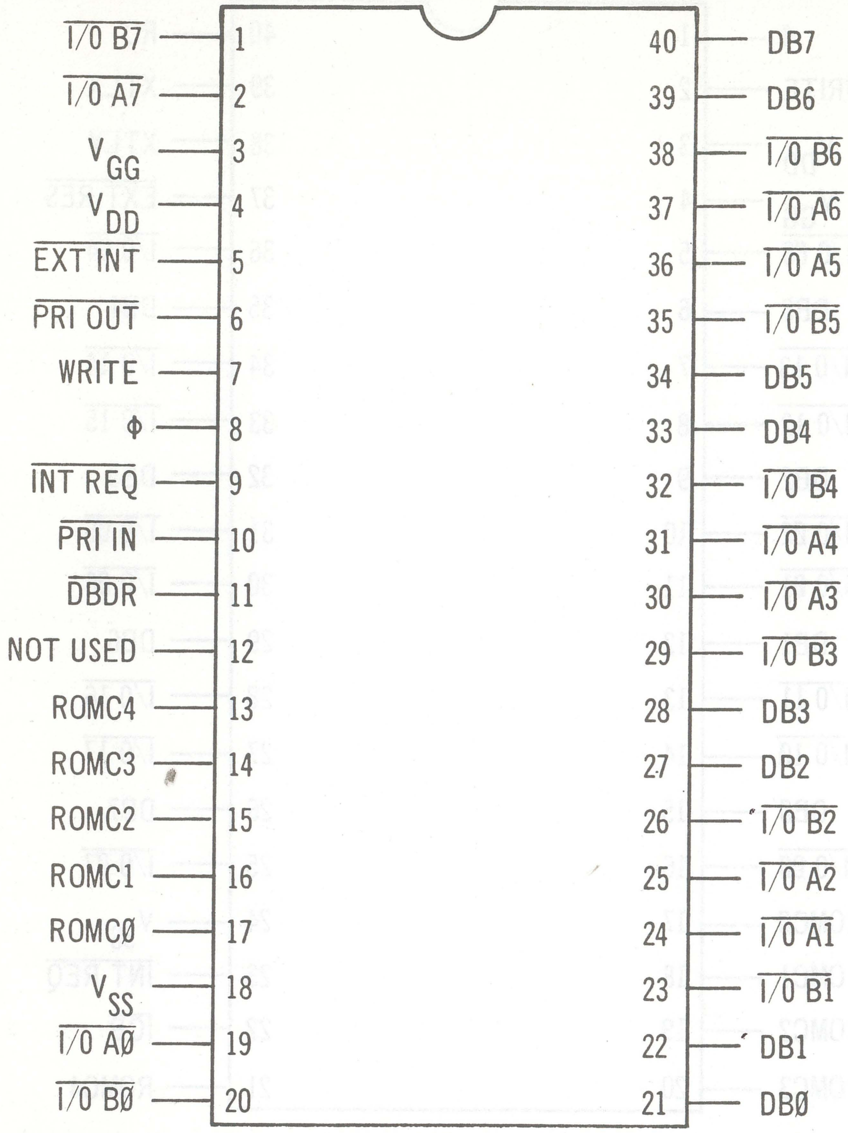


Fig. 9-14. Waveform of the tone output from the CPU in the 1-player, first-ball mode. Scope controls are 2 ms/div for the horizontal and 1V/div for the vertical.




| PIN NAME | DESCRIPTION | TYPE |
|---|---|---|
| DBØ - DB7 | Data Bus Lines | Bidirectional |
| Φ, WRITE | Clock Lines | Output |
| $\overline{\text{I/Ø ØØ}}$ - $\overline{\text{I/O Ø7}}$ | I/0 Port Zero | Bidirectional |
| $\overline{\text{I/O 1Ø}}$ - $\overline{\text{I/O 17}}$ | I/0 Port One | Bidirectional |
| RC | RC Network Pin | Input |
| ROMCØ - ROMC4 | Control Lines | Output |
| $\overline{\text{EXT RES}}$ | External Reset | Input |
| $\overline{\text{INT}}$ REQ | Interrupt Request | Input |
| $\overline{\text{ICB}}$ | Interrupt Control Bit | Output |
| XTLX | Crystal Clock Line | Output |
| XTLY | External Clock Line | Input |
| $V_{SS}$, $V_{DD}$, $V_{GG}$ | Power Lines | Input |

Fig. 9-15. Pin layout for the 3850 CPU.




| PIN NAME | DESCRIPTION | TYPE |
|---|---|---|
| I/Ø AØ - I/0 A7 | I/0 Port A | Bidirectional |
| I/0 BØ - I/0 B7 | I/0 Port B | Bidirectional |
| DBØ - DB7 | Data Bus | Input |
| ROMCØ - ROMC4 | Control Lines | Input |
| Φ, WRITE | Clock Lines | Input |
| EXT INT | External Interrupt | Input |
| PRI IN | Priority In | Input |
| PRI OUT | Priority Out | Output |
| INT REQ | Interrupt Request | Output |
| DBDR | Data Bus Drive | Output |
| $V_{SS}$, $V_{DD}$, $_{GG}$ | Power Supply Lines | Input |

Fig. 9-16. Pin layout for the 3851 PSU.

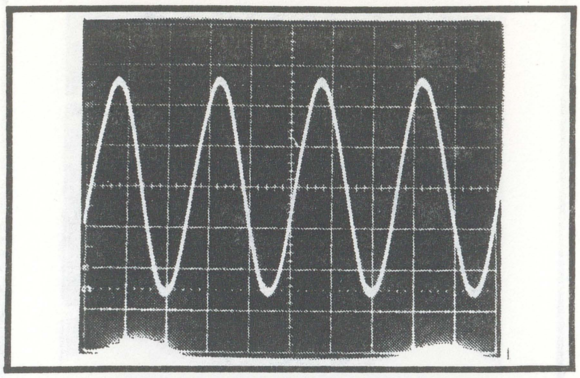


Fig. 9-17. Waveform at pin 37 of the 3850 CPU in 614-1000 and 614-3000. This is the clock input. Scope controls are 0.2 $\mu$s/div for horizontal and 1V/div for vertical.

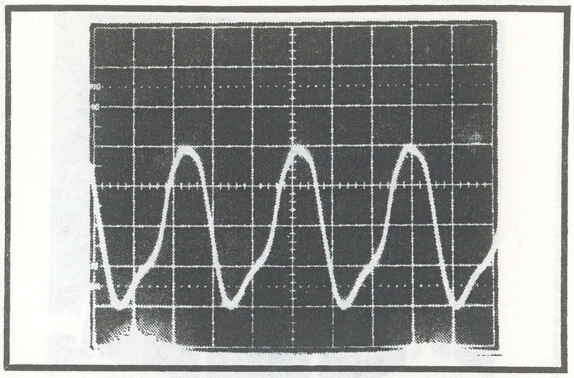


Fig. 9-19. Clock input at pin 1 of the MK3870 CPU in the 614-2000. Scope controls are at 1 $\mu$s/div for the horizontal and 1V/div for the vertical.

of the control pulse is shown in Fig. 9-23. If these check good, and in most cases they should, then proceed to step 7. If any of them do not seem right, proceed to step 8.

7. Check the data bus lines at pins 6, 9, 12, 15, 26, 29, 32, and 35 of the CPU. Make sure the signals on these lines read PSU #1 and PSU #2. There should be fast-switching pulses on these pins. A typical data bus line is shown in Fig. 9-24. Also make sure these are not shorted together. This could be done by holding the scope probe on one and momentarily grounding the others.
8. Check pins 11, 10, and 5 of the CPU. There should be square wave outputs on them. If pin 11 has a pulse (as shown in Fig. 9-25), then the CPU and PSU are functioning normally. If it is just a high, then there is something wrong on the data bus or the control lines, or PSU #1 may be bad. Refer back to step 6 and change PSU #1 before changing the CPU.

## FAIL-SAFE CIRCUIT

This circuit is designed to prevent multiplexing if the CPU or PSU do not strobe properly. This protects the display and light bulbs from getting damaged. In other words, if pin 11 of CPU is high, pin 4 of op amp Q262 ($\mu$A3401) would be high, which results in preventing the decoders (7445s) from decoding. If there is a pulse on pin 11 of the CPU (as shown in Fig. 9-25) and pin 4 of the op amp remains high, then check the fail-safe circuit thoroughly. Check the external strapping on connector D, pins 1 and 2 (strobe enable). Check for broken resistors or diodes in that section. If they seem good, replace the 0.01 $\mu$F capacitors and IN4004 diodes before changing the op amp itself.

Concerning model 614-2000, if pin 9 of CPU is high, pin 4 of the op amp (LM3900) could be high, which results in preventing the decoders (7445)

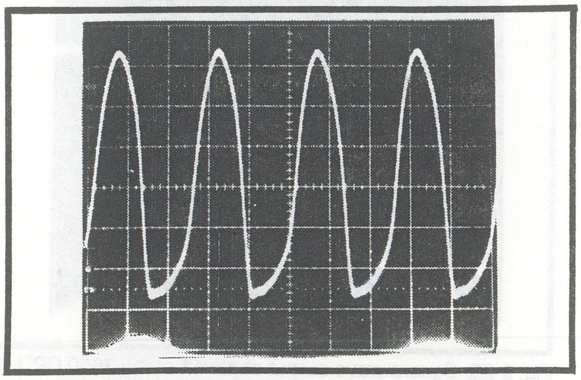


Fig. 9-18. Clock output at pin 39 of the 3850 CPU in the 614-1000 and 614-3000. This waveform was taken with the scope control at 0.2 $\mu$s/div for the horizontal and 1V/div for the vertical.

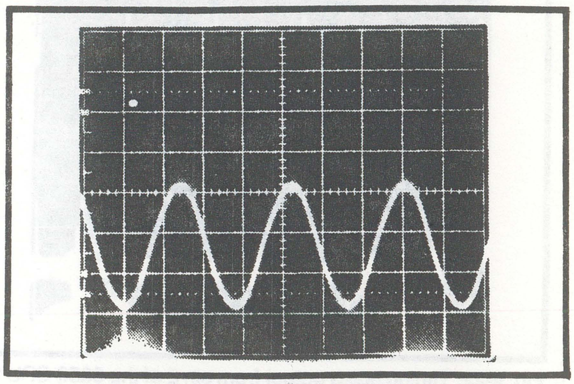


Fig. 9-20. Clock output at pin 2 of the MK3870 CPU in the 614-2000. Scope controls are at 1 $\mu$s/div for the horizontal and 1V/div for the vertical.

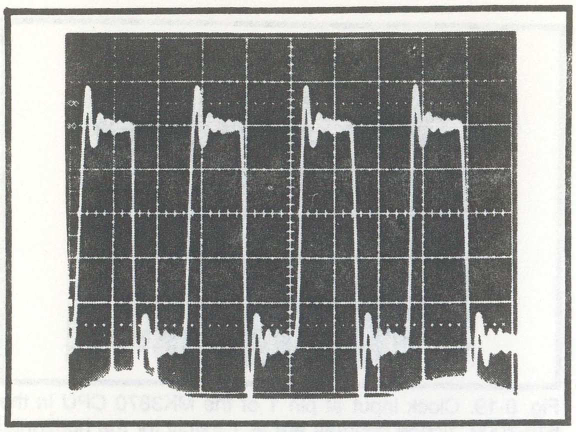


Fig. 9-21. Timing pulse output to both PSUs from pin 1 of the 3850 CPU in the 614-1000 and 614-3000. Scope controls are at 0.2 μs/div for the horizontal and 1V/div for the vertical.

from decoding. If there is a pulse on pin 9 of the CPU (as shown in Fig. 9-25) and pin 4 of the op amp remains high, then check the fail-safe circuit thoroughly. Check the external strapping on connector D, pins 8 and 9 (strobe enable). Check closely for broken resistors or diodes in that section. If they seem good, replace the 0.01 μF capacitors and the IN4004 diodes before changing the op amp itself.

### TILT LIGHT

This is the only light other than the 5.25V AC lights which is not in the matrix but is controlled by the logic board. If the tilt light does not light when the tilt switch is closed, check the bulb and socket first. Then check pins 24 and 25 of PSU #1 and see if they go high when the tilt switch is closed with the game in the play mode. If this checks out, check the

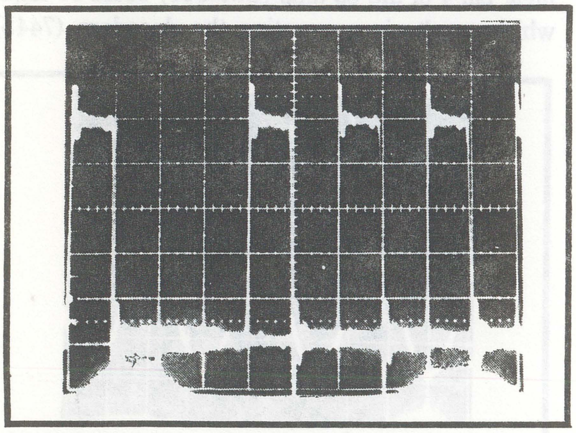


Fig. 9-22. Timing pulse output from pin 2 of the 3850 CPU to both PSCs in the 614-1000 and 614-3000. Scope controls are at 0.5 μs/div for the horizontal and 1V/div for the vertical.

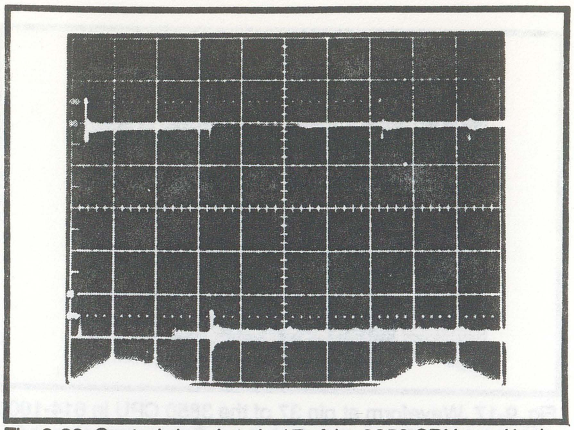


Fig. 9-23. Control signal at pin 17 of the 3850 CPU used in the 614-1000 and 614-3000. Scope controls are at 1 μs/div for the horizontal and 1V/div for the vertical.

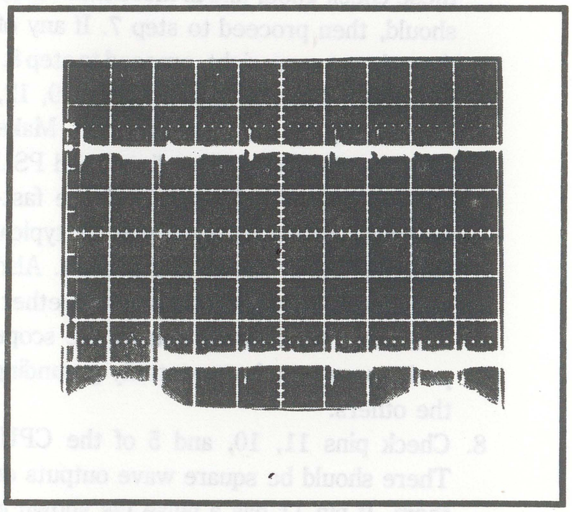


Fig. 9-24. Data bus line signal at pin 6 of the 3850 CPU. Scope controls are at 1 μs/div for the horizontal and 1V/div for the vertical.

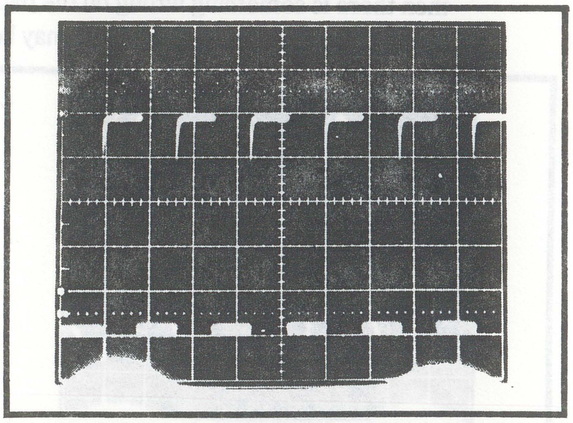


Fig. 9-25. Square wave output at pin 11 of the 3850 CPU. If this signal is present, the CPU and PSUs are working normally. Scope controls are at 2 ms/div for the horizontal and 1V/div for the vertical.

output of the decoder (7445) at pin 9 and see if it goes low or not. If it does, the decoder is good; change transistor array Q270 (FPQ3724). If pin 9 does not go low, change the decoder.

On the 614-2000, the tilt light is the only light, other than the 5.25V AC light, that is not in the matrix but is controlled by the logic. If the tilt light does not light when the tilt switch is closed, check the bulb and socket first. If the bulb appears to be good, check pin 6 of the CPU and see if it goes high when the tilt switch is closed with the game in the play mode. If this is okay, check driver L3's output. If the tilt light remains on all the time, check driver L3 for a short. If it appears to be good, check pins 6 of the CPU. If it is high without the tilt switch being closed, change the CPU.

## SERVICE PROCEDURES

The following procedures cover switch adjustments, cleaning the playfield, lamp replacement, and fuse replacement. Figure 9-9 indicates the locations of various switches and lamps on the playfield.

### Rollover Switch

The ball must actuate the switch when rolling through the rollover area from both directions. To adjust the actuator proceed as follows:

1. Form the actuator as shown in Fig. 9-26 to ensure that the switch is actuated when the ball rolls over it in either direction. The actuator should be centered in the slot when adjusted and not resting above the playfield surface.
2. Check the operation of the switch by rolling a ball over the actuator. The ball should not stop or hang up.
3. Check for spring return after the ball has passed over the actuator. The spring should return to the up position.

### Sling Shot & Side Rubber Switch

The rubber bumper must be evenly stretched around all posts. The switch actuator blade must be adjusted to make the switch actuate (clicking sound) when it moves 0.0625 inches (1.587 mm) from the rubber bumper. If the switch is adjusted too close, the sling shot will chatter. Refer to Fig. 9-27.

### Target Switch

The switch must actuate and reset (click, click) freely in the playfield slot. The rear stop bracket must be adjusted for 0.1562 inches from the actuation point of the switch. Make this adjustment by bending the stop bracket. Refer to Fig. 9-28.

### Thumper Bumper Switch

The thumper bumper spoon must be centered about the thumper bumper actuating point in all directions. Refer to Fig. 9-29. When the thumper bumper wafer is depressed at any point on the

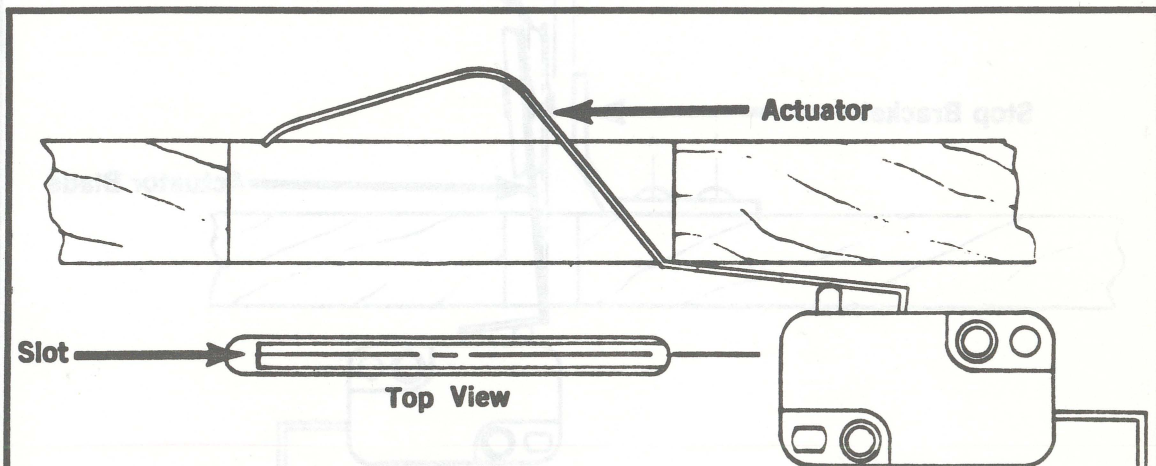



Fig. 9-26. Rollover switch adjustment. Roll the ball over the actuator in both directions to see if the switch trips.

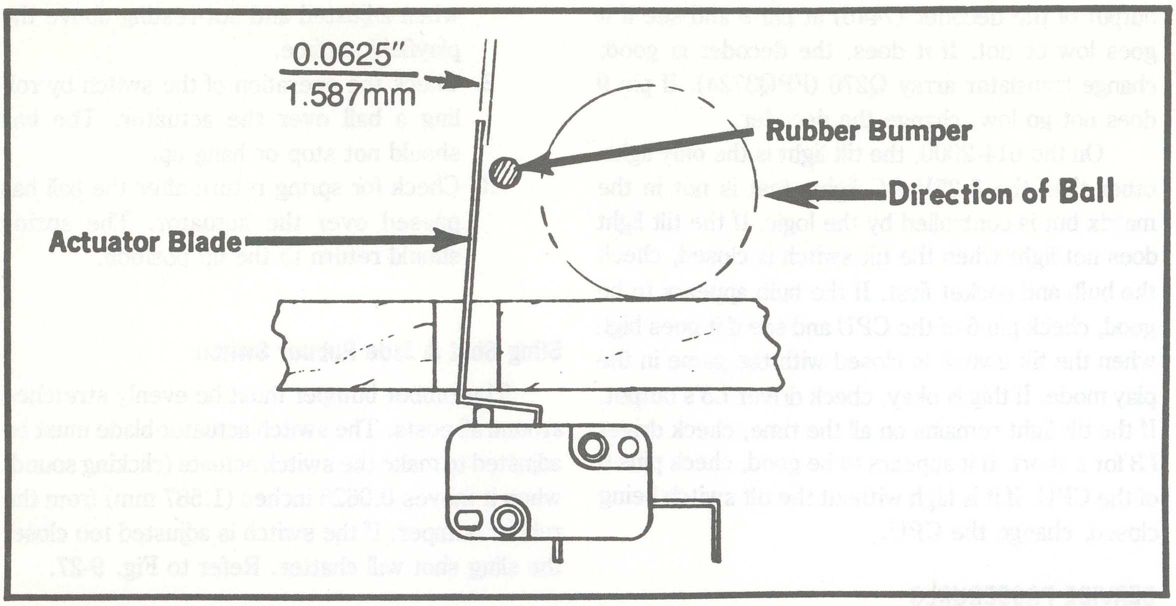



Fig. 9-27. Sling shot and side rubber switch adjustment. Adjust the actuator so that the switch trips within the limits shown.

periphery the switch must actuate. Adjust the switch actuator arm by bending it to meet this requirement. Note the 0.0625-inch (1.587 mm) clearance of the bumper wafer in the resting position.

### Ball Return Switch

To adjust the ball return switch, adjust the switch actuator to actuate when the ball stops in the position shown in Fig. 9-30. If the switch actuates before the ball returns to the position shown, ball ejection will start prematurely and cause the ball to hang up.

### Spinner Target Switch

Adjust the switch actuation arm by bending it until the switch actuates (flick) in the lower third of spinner travel. See Fig. 9-31.

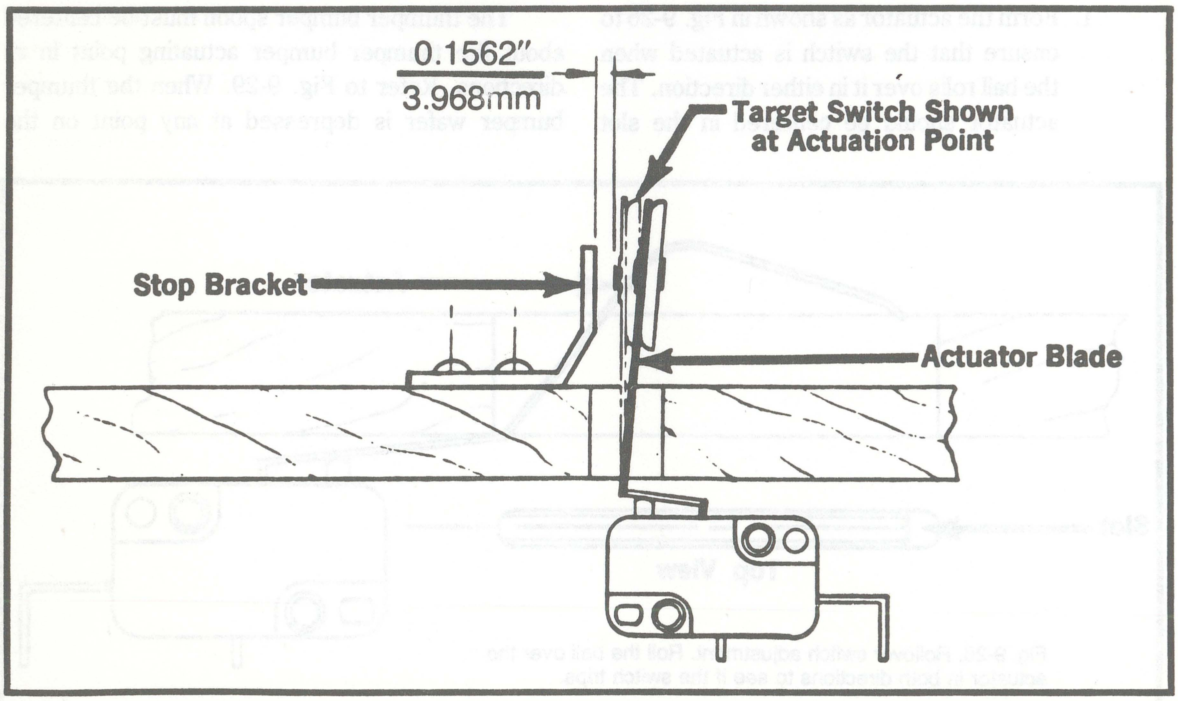



Fig. 9-28. Target switch adjustment. Bend the stop bracket to make the switch operate as indicated.

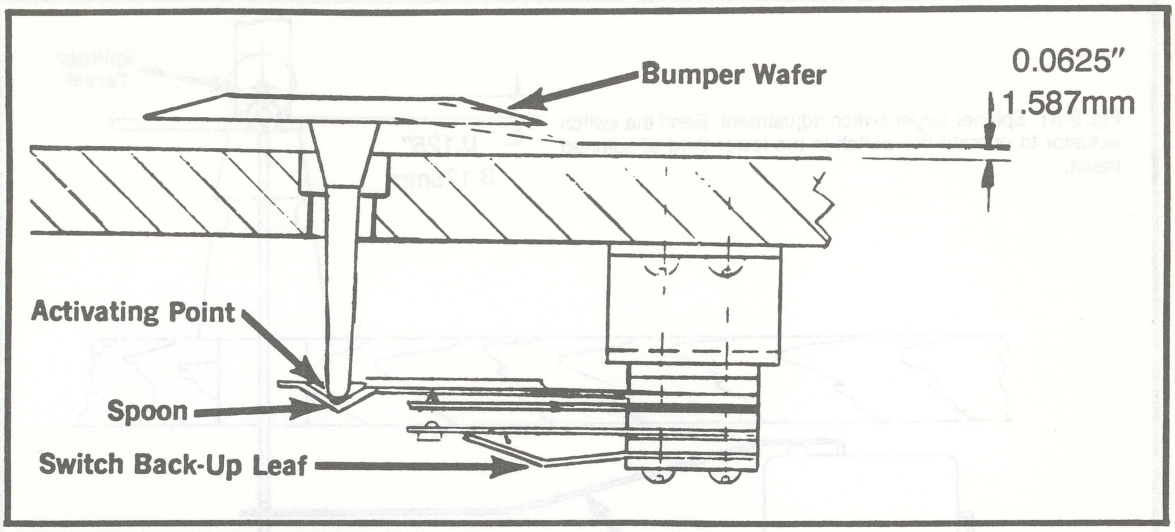


Fig. 9-29. Thumper bumper switch adjustment. First center the switch spoon. Then bend the switch actuator to operate the switch within the specifications shown.

### Cleaning Playfield

Remove the playfield glass as shown in Figs. 9-32 and 9-33. Wipe the playfield surface with a soft rag or slightly dampened towel.

### Servicing Bottom of Playfield

Remove the three screws in the front of the cabinet as shown in Fig. 9-32. Lift off the trim molding. Carefully slide out the playfield glass as shown in Fig. 9-33. Remove the two screws in the bracket holding down the playfield as shown in Fig. 9-33. Raise the playfield from the front and place it against the cabinet back box with the playfield resting in the notches provided in the playfield support rails. Refer to Fig. 9-34. The playfield bottom (lamps, switches, and solenoids), flipper switches, tilt assembly, and power supply are now easily accessible.

### Tilt Pendulum

The tilt pendulum, which is located in the left-front section of the cabinet, can be adjusted as desired. To make the tilt more sensitive, loosen the thumb screw in the tilt b6b. Refer to Fig. 9-35.

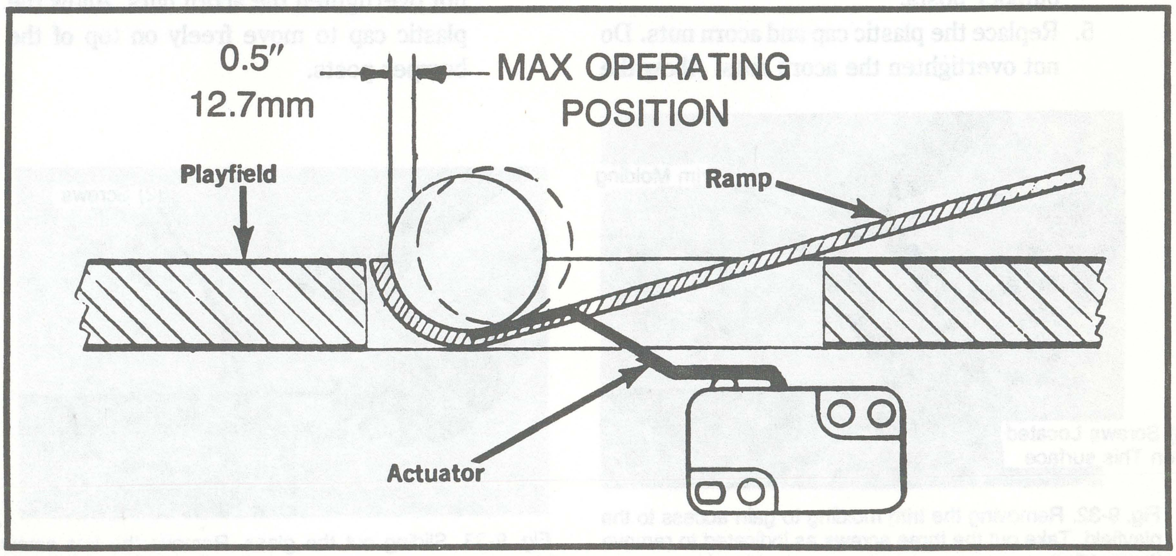


Fig. 9-30. Ball return switch adjustment. Bend the actuator to operate the switch as the ball stops in the position shown.

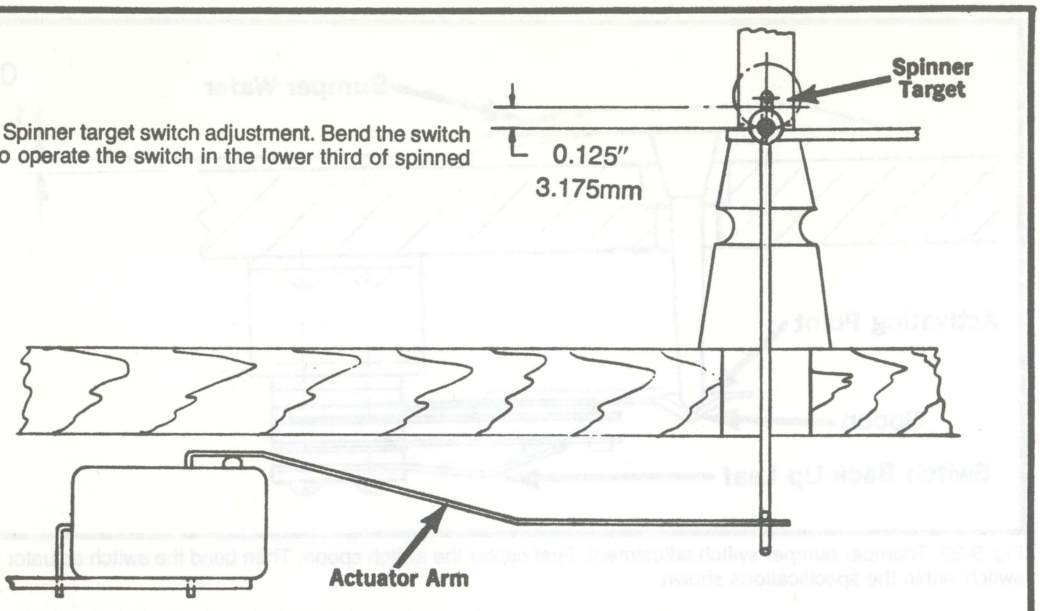



Fig. 9-31. Spinner target switch adjustment. Bend the switch actuator to operate the switch in the lower third of spinned travel.

Raise the bob closer to the bob ring. Then tighten the thumb screw. To make the tilt less sensitive, lower the bob.

### Bumper Rubber Replacement

1. Remove the acorn nuts holding the plastic cap as shown in Fig. 9-36.
2. Remove the plastic cap.
3. Remove the worn bumper rubber.
4. Stretch the new bumper rubber around the bumper posts. Tension on the bumper rubber must be evenly distributed about all bumper posts.
5. Replace the plastic cap and acorn nuts. Do not overtighten the acorn nuts. Allow the plastic cap to move slightly on top of the bumper posts.

### Playfield Lamp Replacement

1. Remove the acorn nuts from the plastic cap covering the burned out lamp. Refer to Fig. 9-36.
2. Remove the plastic cap.
3. Pull the burned out lamp straight out of the receptacle. Insert a new lamp.
4. Replace the plastic cap and acorn nuts. Do not overtighten the acorn nuts. Allow the plastic cap to move freely on top of the bumper posts.

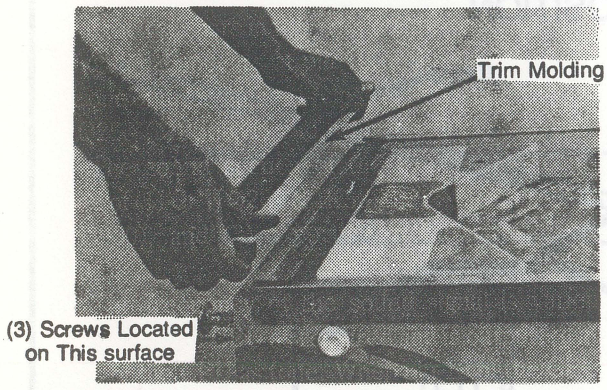



Fig. 9-32. Removing the trim molding to gain access to the playfield. Take out the three screws as indicated to remove the molding.

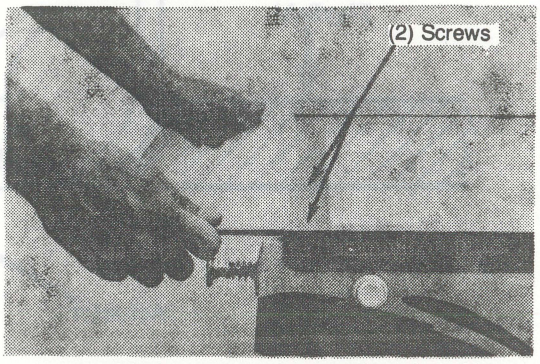



Fig. 9-33. Sliding out the glass. Remove the two screws shown, then carefully slide out the glass.

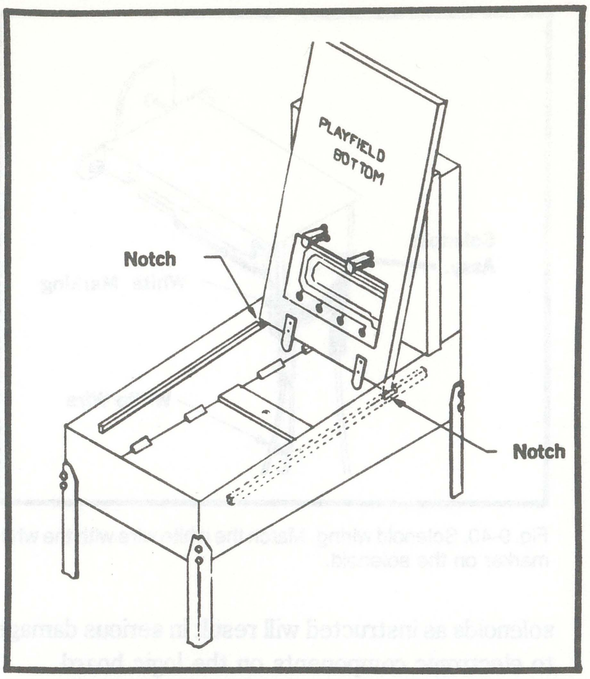



Fig. 9-34. Positioning the playfield. Place the playfield in the two notches shown, then let it rest against the cabinet back.

## PC Board Lamp Replacement

1. Twist lamp receptacle counterclockwise to remove it from the PC board. Refer to Fig. 9-37.
2. Pull the burned out lamp straight out of the receptacle. Insert a new lamp.
3. Twist lamp receptacle clockwise to position it back in the PC board.

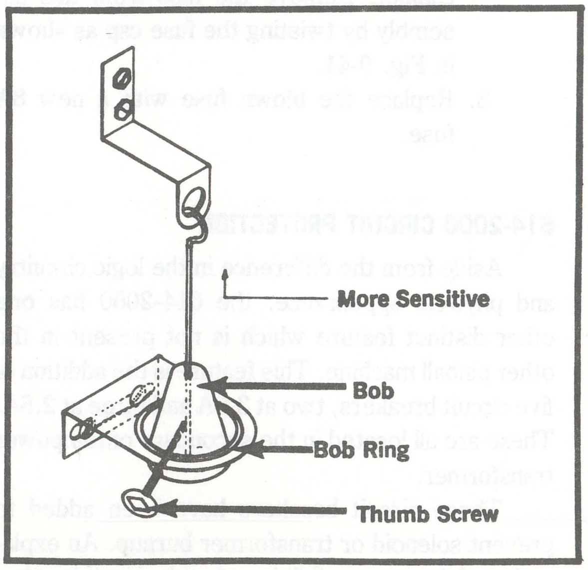



Fig. 9-35. Tilt pendulum adjustment. Raise the bob to make it more sensitive.

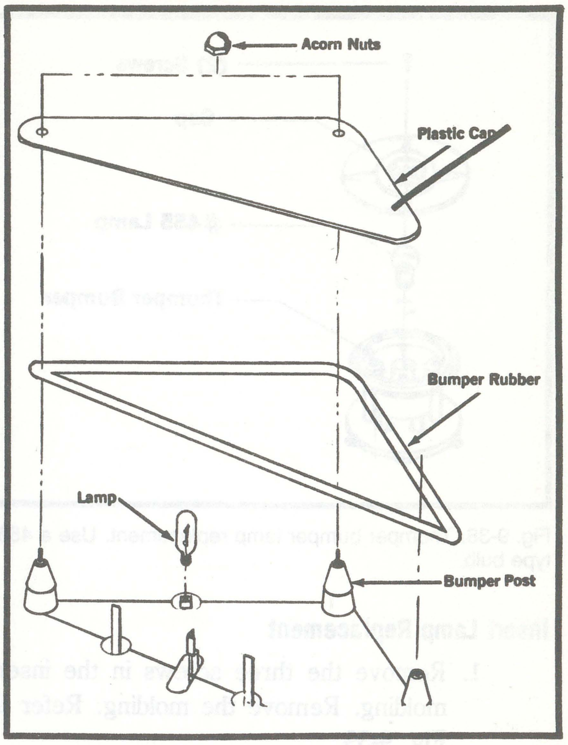



Fig. 9-36. Bumper rubber replacement. Do not overtighten the acorn nuts.

## Bumper Lamp Replacement

1. Remove the two screws in the thumper bumper cap.
2. Remove the thumper bumper cap.
3. Twist out the burned out lamp and replace it with a new 455-type bulb. Refer to Fig. 9-38.
4. Replace the thumper bumper cap and screws.

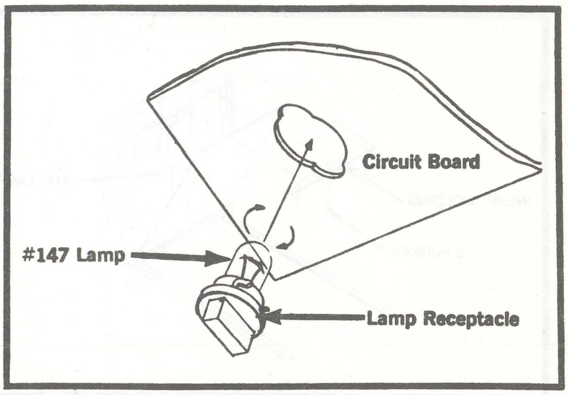



Fig. 9-37. PC board lamp replacement. Turn the lamp assembly counterclockwise to remove and clockwise to install.

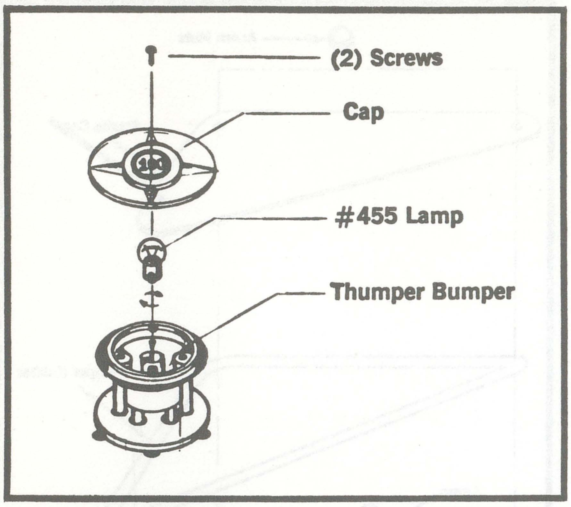



Fig. 9-38. Thumper bumper lamp replacement. Use a 455-type bulb.

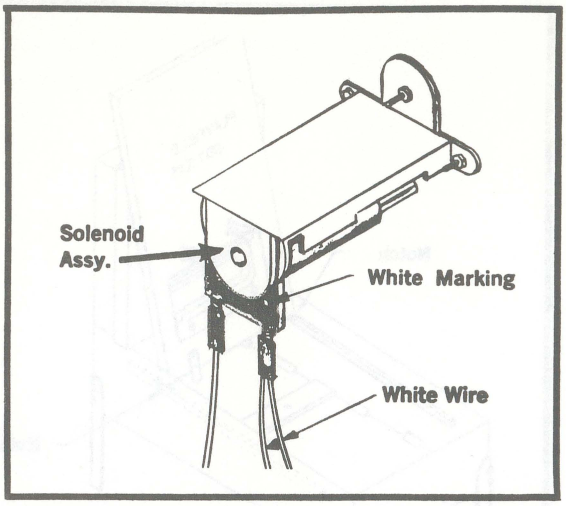



Fig. 9-40. Solenoid wiring. Match the white wire with the white marker on the solenoid.

### Insert Lamp Replacement

1. Remove the three screws in the insert molding. Remove the molding. Refer to Fig. 9-39.
2. Remove the insert display glass.
3. Replace the burned out lamp. Use a 147-type lamp.
4. Replace the display glass, molding, and three screws.

### Solenoid Wiring

If for any reason the wiring of any solenoid is removed, it must be replaced in the following manner: The white wire must be connected to the terminal identified with a white marking. The wire is attached by pushing the connector on the spade terminal. Refer to Fig. 9-40. Failure to connect the solenoids as instructed will result in serious damage to electronic components on the logic board.

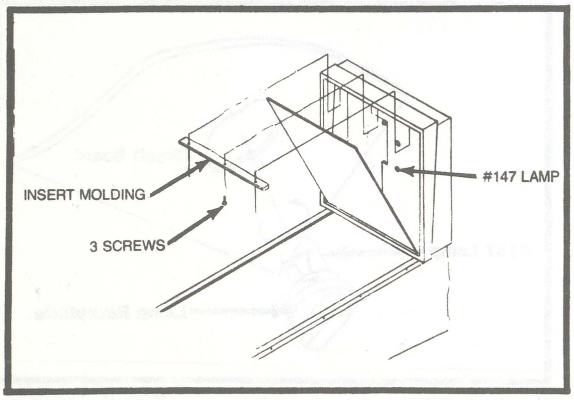



Fig. 9-39. Display insert lamp replacement. Use a 147-type bulb.

### Fuse Replacement

This procedure does not apply to the 614-2000 since there is no replaceable fuse in that model.

1. Remove the playfield glass as shown in Figs. 9-32 and 9-33. Raise the playfield as shown in Fig. 9-34.
2. The transformer assembly is located in the right-rear corner of the bottom of the cabinet. Remove the fuse from this assembly by twisting the fuse cap as shown in Fig. 9-41.
3. Replace the blown fuse with a new 8A fuse.

## 614-2000 CIRCUIT PROTECTION

Aside from the difference in the logic circuitry and physical appearance, the 614-2000 has one other distinct feature which is not present in the other pinball machine. This feature is the addition of five circuit breakers, two at 3.9A and three at 2.5A. These are all located in the secondary of the power transformer.

These circuit breakers have been added to prevent solenoid or transformer burnup. An explanation of the responsibilities of each circuit breaker is as follows:

## 3.9A Circuit Breakers

As stated, there are two circuit breakers of this rating. One is inserted in the playfield illumination line. It monitors the current through nine display lights on the periphery of the playfield and both thumper bumper lamps.

The other 3.9A circuit breaker is located in the scorebox illumination line. It monitors current through the six display lights behind the scorebox.

## 2.5A Circuit Breakers

As mentioned above, there are three circuit breakers in the 614-2000 of this rating. One of these monitors light current, while the other two monitor solenoid current. The circuit breaker monitoring light current is in the feature light line, which supplies current to all lights connected with switches and bonus scoring.

One of the 2.5A circuit breakers monitors current through the solenoids located on the right side of the playing surface, including the ball return solenoid. The final 2.5A circuit breaker monitors current through all solenoids located on the left side of the playing surface.

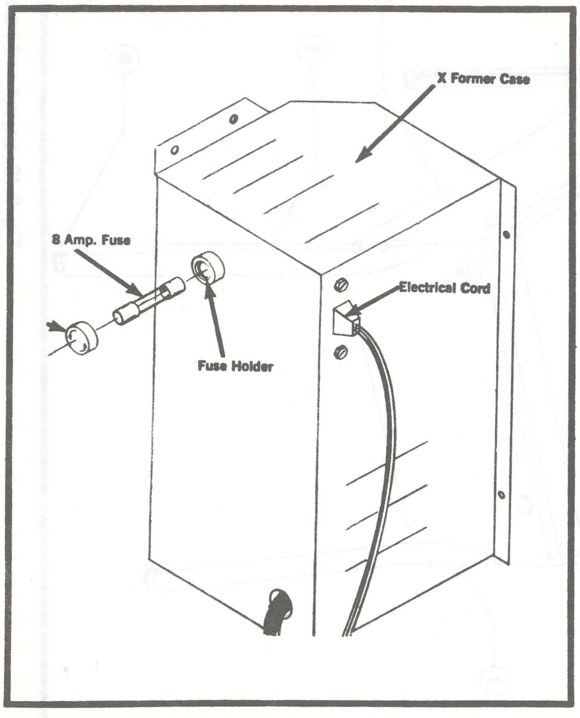



Fig. 9-41. Fuse replacement in the 614-1000 and 614-3000. The transformer assembly is located in the right-rear corner of the cabinet. Use an 8A fuse when replacing.

## ELECTROMECHANICAL TROUBLES

The following information is a list of some typical electromechanical symptoms that could occur to a pinball machine. Each symptom is displayed in boldface type as a heading. Directly below each symptom is a step-by-step procedure that can help locate the malfunctioning component or components. Or, in some cases, the steps indicate a remedy or adjustment procedure.

### No Lites—Nothing Works

1. Make sure the electrical cord is firmly inserted in the wall outlet.
2. Depress the on/off switch.
3. Reset the circuit breaker.
4. Check the 8A fuse.
5. Check the power supply connections.

### Insert Lites Okay—Playfield Lites Off

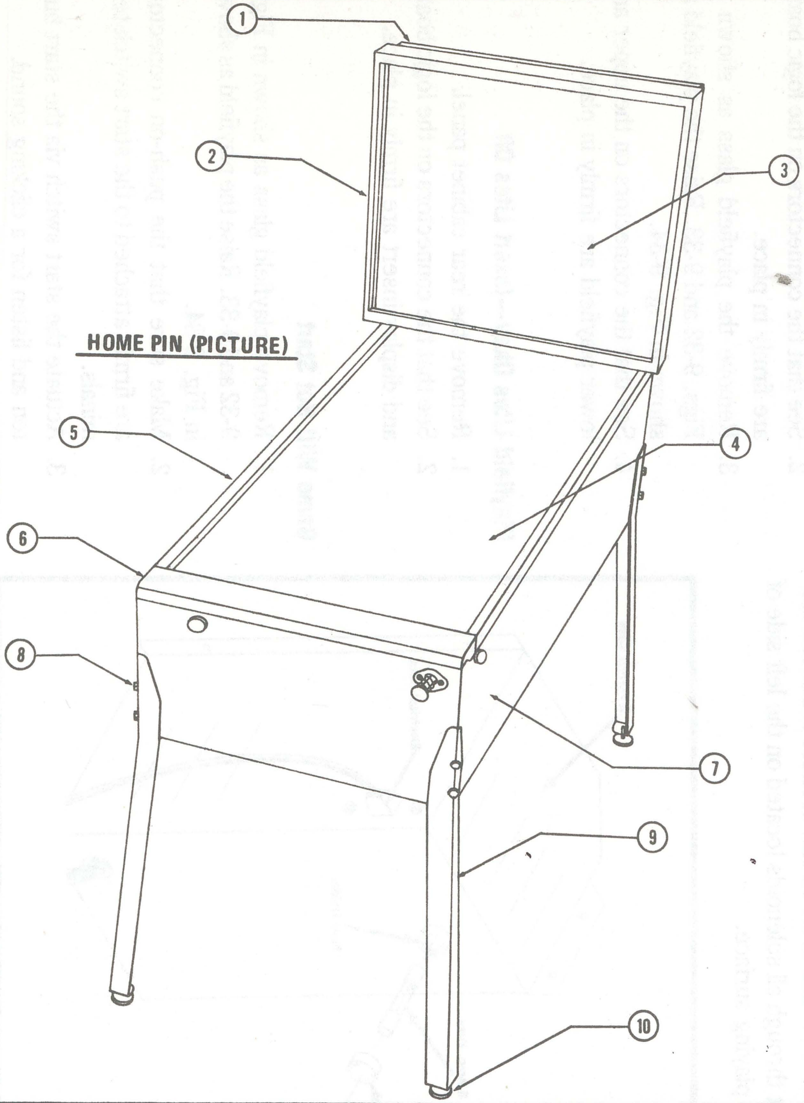
1. Remove the rear cabinet panel.
2. See that the connectors on the logic board are firmly in place.
3. Remove the playfield glass as shown in Figs. 9-32 and 9-33. Raise the playfield as shown in Fig. 9-34.
4. See that the connectors on the upper and lower playfield are firmly in place.

### Playfield Lites Okay—Insert Lites Off

1. Remove the rear cabinet panel.
2. See that the connectors on the logic board and display insert are firmly in place.

### Game Will Not Start

1. Remove playfield glass as shown in Figs. 9-32 and 9-33. Raise the playfield as shown in Fig. 9-34.
2. Make sure that the push-on connectors are firmly attached to the start switch terminals.
3. Actuate the start switch via the start button and listen for a clicking sound.
4. If the start button stroke is too short to actuate the switch, the switch blade can be bent slightly to obtain actuation.




ORDER BY PART NUMBER ONLY

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0614-00516-0100 | BACK BOX - EVEL KNIEVEL |
| | 0614-00501-0200 | BACK BOX - CAPTAIN FANTASTIC |
| | 0614-00516-0200 | BACK BOX - FIREBALL II |
| | 0017-00102-0021 | 1/4 - 20 x 1-3/4 HEX HD. BOLT, (2) |
| | 0017-00104-0039 | STEEL WASHER (2) |
| 2 | 0614-00902-0100 | BACK BOX FRAME - EVEL KNIEVEL |
| | 0614-00902-0200 | BACK BOX FRAME - CAPTAIN FANTASTIC & FIREBALL II |
| 3 | 0614-00920-0100 | BACK BOX GLASS - CAPTAIN FANTASTIC |
| | 0614-00920-0200 | BACK BOX GLASS - EVEL KNIEVEL |
| | 0606-00901-0000 | BACK BOX GLASS - FIREBALL II |
| | 0017-00101-0062 | #6 x 3/4 PHIL. PAN, HD S.M.S. |
| 4 | 0606-00919-0000 | NICKEL PL. (10) |
| 5 | 0614-00100-000 | DECORATIVE SIDE CHANNEL (2) |
| | 0017-00101-0357 | #5 x ½ PHIL. PAN. HD. S.M.S. (10) |
| 6 | A614-0019-0000 | FRONT DECORATIVE MLDG. ASSY. |
| | 0017-00101-0055 | #10 x 1-1/4 PHILIPS PAN HD. S.M.S. NICKEL PL. (3) |
| 7 | 0614-00515-0100 | BOTTOM CABINET - EVEL KNIEVEL |
| | 0614-00509-0200 | BOTTOM CABINET - CAPTAIN FANTASTIC |
| | 0614-00515-0200 | BOTTOM CABINET - FIREBALL II |
| 8 | 0017-00102-0063 | 3/8 - 16 x 2-3/8 ACORN HD. MTG. BOLTS (8) |
| 9 | 0606-00101-01PA | LEGS (4) |
| 10 | 0017-00102-0048 | LEG LEVELERS (4) |
| | 0017-00103-0026 | LEG LEVELER NUTS (4) |

Fig. 9-42. Layout and parts list for major cabinet items.

#### Ball Won't Eject to Shooter

1. Remove the playfield glass as shown in Figs. 9-32 and 9-33. Raise the playfield as shown in Fig. 9-34.
2. Make sure that the push-on connectors are firmly attached to the solenoid terminals and ball return switch terminals.
3. Check the switch adjustment. Refer to Fig. 9-30.

#### Switch Won't Score

1. Remove the playfield glass. See Figs. 9-32 and 9-33.
2. Operate the switch manually and listen for actuation (clicking sound).
3. Adjust the switch indicated. Refer to Figs. 9-26 through 9-31.

#### Solenoid Doesn't Operate

1. Remove the playfield glass. See Figs. 9-32 and 9-33.
2. Raise the playfield and position it as shown in Fig. 9-34.
3. Make sure the push-on connectors are firmly attached to the solenoid terminals.
4. Check the adjustment of the solenoid-operation switch for a click. If no click is heard, adjust it as indicated.

#### Weak/Dead Flipper Solenoid

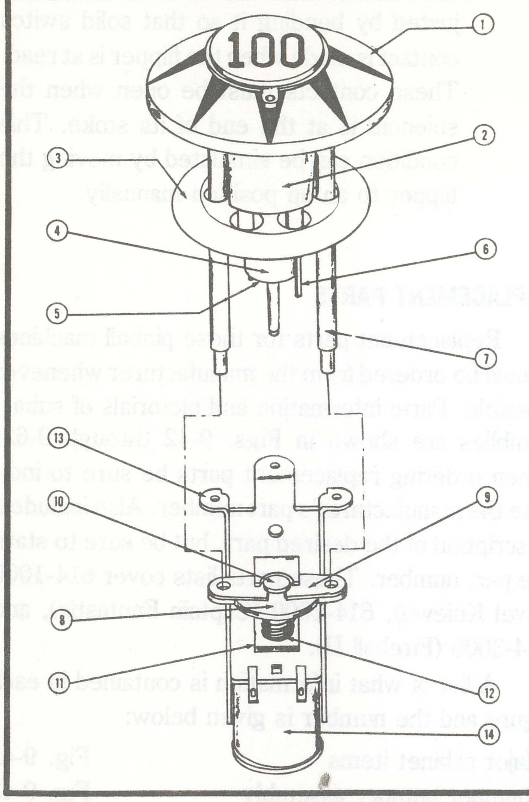
1. Remove the playfield glass. See Figs. 9-32 and 9-33. Raise the playfield into position. See Fig. 9-34.
2. Make sure that the push-on connectors are firmly attached to the flipper solenoid terminals.
3. Make sure that the flipper button switch is making solid contact. The switch may be adjusted by bending the switch blade slightly.
4. Clean the flipper button switch with a piece of fine emery cloth to ensure continuity.
5. When the flipper operates weakly, the switch on the coil assembly can be adjusted by bending it so that solid switch contact is made when the flipper is at read. These contacts must be open when the solenoid is at the end of its stoke. This condition can be simulated by moving the flipper to an up position manually.

### REPLACEMENT PARTS

Replacement parts for these pinball machines should be ordered from the manufacturer whenever possible. Parts information and pictorials of subassemblies are shown in Figs. 9-42 through 9-62. When ordering replacement parts be sure to indicate the manufacturer's part number. Also include a description of the desired part, but be sure to state the part number. These parts lists cover 614-1000 (Evel Knievel), 614-2000 (Captain Fantastic), and 614-3000 (Fireball II).

A list of what information is contained in each figure and the number is given below:

| | |
|---|---|
| Major cabinet items | Fig. 9-42 |
| Thumper bumper assembly | Fig. 9-43 |
| Flipper unit assembly | Fig. 9-44 |
| Flipper unit assembly | Fig. 9-45 |
| Flipper and tilt assemblies | Fig. 9-46 |
| Ball shooter assembly | Fig. 9-47 |
| Sling shot assembly | Fig. 9-48 |
| Ball return kicker assembly | Fig. 9-49 |
| Flipper button assembly | Fig. 9-50 |
| 614-00912 power supply | Fig. 9-51 |
| 606-00906 power supply | Fig. 9-52 |
| Upper PC board | Fig. 9-53 |
| Lower PC board | Fig. 9-54 |
| 614-2000 logic board diagram | Fig. 9-55 |
| 614-2000 logic board parts | Fig. 9-56 |
| Evel Knievel/Fireball II logic board diagram | Fig. 9-57 |
| Evel Knievel/Fireball II logic board parts | Fig. 9-58 |
| Playfield assembly | Fig. 9-59 |
| Playfield assembly (continued) | Fig. 9-60 |
| Bottom arch assembly | Fig. 9-61 |
| Transformer | Fig. 9-62 |

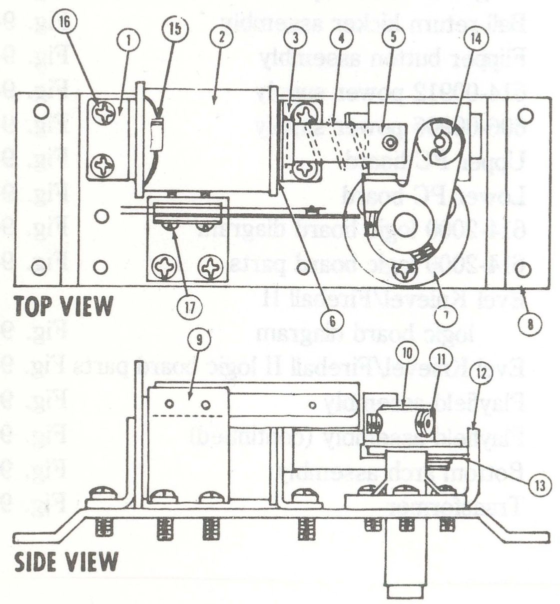



ORDER BY PART NUMBER ONLY

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0017-00042-0124 | THUMPER CAP |
| 2 | 0017-00042-0122 | BUMPER BODY |
| 3 | 0017-00042-0121 | THUMPER WAFER |
| 4 | 0017-00042-0123 | BUMPER BASE |
| 5 | 0010-00236-0000 | SPRING (INSIDE BUMPER BASE) |
| 6 | 0017-00031-0031 | SOCKET (LAMP) |
| 7 | 0606-00040-0000 | FLANGE & STUD ASSY. |
| 8 | 0017-00009-0339 | BAKELITE PLATE |
| 9 | 0017-00009-0338 | STEEL PLATE |
| 10 | 0606-00728-0000 | PLUNGER |
| 11 | 0017-00009-0337 | COIL BRACKET |
| 12 | 0010-00237-0000 | SPRING |
| 13 | 0606-00033-0000 | CORE PLUG ASSY. |
| 14 | A614-00014-0000 | COIL ASSY. |
| | 0606-00011-0000 | UPPER THUMPER BUMPER ASSY. COMPLETE (MINUS CAP & SCREWS) |
| | 0606-00010-0000 | COIL & BRACKET ASSY. |
| | | ITEMS NOT ILLUSTRATED |
| | 0017-00003-0061 | THUMPER BUMPER LAMP (2) (UNDER CAP) |
| | 0064-030XX-XXDX | DIODE (UNDER COIL BRACKET) |
| | A614-00004-0000 | MAKE BREAK - THUMPER BUMPER SWITCH ASSY. |
| | 0017-00009-0411 | SWITCH BRACKET |
| | 0020-00202-0000 | SWITCH PLATE |
| | 0520-00138-0000 | SWITCH PLATE - TAPPED |
| | 0017-00101-0528 | #5 - 40 X 3/4 R.H. M.S. |

Fig. 9-43. Exploded view and parts list of the thumper bumper and coil assembly.

NO. 614 FLIPPER UNIT ASSY.
(LEFT & RIGHT) CAPT. FANTASTIC & FIREBALL II
(LEFT) EVEL KNIEVEL



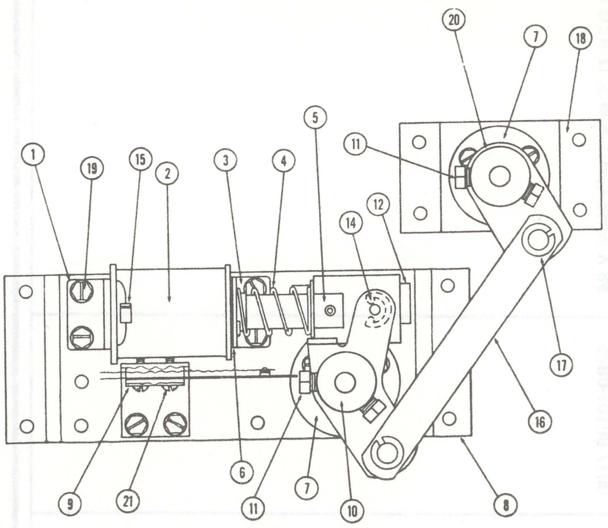

LEFT & RIGHT FLIPPER UNIT ASSY. – CAPT.FANTASTIC & FIREBALL II
LEFT FLIPPER UNIT ASSY.–EVEL KNIEVEL

ORDER BY PART NUMBER ONLY

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0606-00030-0000 | CORE PLUG & BRACKET ASSY. |
| 2 | A614-00016-0000 | COIL |
| 3 | 0017-00009-0343 | COIL BRACKET |
| 4 | 0010-00246-0000 | SPRING |
| 5 | 0606-00029-0000 | PLUNGER & LINK ASSY. |
| 6 | 0017-00104-0073 | SPRING WASHER |
| 7 | 0017-00009-0330 | BEARING (FLIPPER) |
| 8 | 0017-00009-0360 | MTG. BRKT. (FLIPPER) |
| 9 | 0606-00017-0000 | SWITCH ASSY. (FLIPPER) |
| 10 | 0606-00038-0000 | LEVER ARM ASSY. (LEFT) |
| | 0606-00037-0000 | LEVER ARM ASSY. (RIGHT) |
| 11 | 0017-00101-0338 | SET SCREW (2) |
| 12 | 0017-00009-0342 | BRACKET (FLIPPER STOP) |
| 13 | 0017-00104-0074 | NYLON WASHER |
| 14 | 0017-00100-0021 | RETAINING RING |
| 15 | 0064-030XX-0XXX | DIODE (IN 4004) |
| 16 | 0017-00101-0754 | #8 - 32 x 3/8 SLOTTED HEX HD. S.T.M.S. (11) |
| 17 | 0017-00101-0520 | #5 - 40 x 3/8 PAN HD. M.S. (2) |
| | 0606-00007-0000 | FLIPPER ASSY. LEFT (COMPLETE) |
| | 0606-00006-0000 | FLIPPER ASSY. RIGHT (COMPLETE) |

Fig. 9-44. Flipper unit assembly and parts list. Left and right flipper for Captain Fantastic and Fireball II. Left flipper for Evel Knievel.

RIGHT FLIPPER UNIT ASSY. - EVEL KNIEVEL



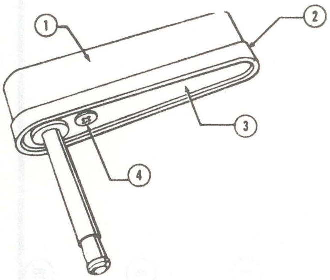
RIGHT FLIPPER UNIT ASSY. - EVEL KNIEVEL

*ORDER BY PART NUMBER ONLY*

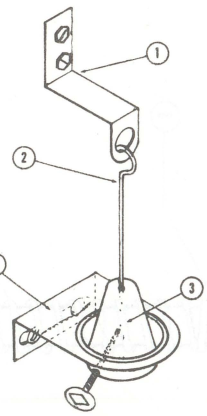
| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0606-00030-0000 | CORE PLUG & BRACKET ASSY. |
| 2 | A614-00016-0000 | COIL |
| 3 | 0017-00009-0343 | COIL BRACKET |
| 4 | 0010-00246-0000 | SPRING |
| 5 | 0606-00029-0000 | PLUNGER & LINK ASSY. |
| 6 | 0017-00104-0073 | SPRING WASHER |
| 7 | 0017-00009-0330 | BEARING (FLIPPER) (2) |
| 8 | 0017-00009-0360 | MTG. BRKT. (FLIPPER) |
| 9 | 0606-00017-0000 | SWITCH ASSY. (FLIPPER) |
| 10 | A614-00038-0000 | LEVER ARM ASSY. (RIGHT) UPPER |
| 11 | 0017-00101-0338 | SET SCREW (4) |
| 12 | 0017-00009-0342 | BRACKET (FLIPPER STOP) |
| | 0017-00104-0074 | NYLON WASHER (NOT SHOWN) |
| 14 | 0017-00100-0021 | RETAINING RING |
| 15 | 0064-030XX-0XXX | DIODE (IN 4004) |
| | A614-00041-0000 | PIVOT LINK ASSY. (CONSISTING OF) |
| 16 | 0614-00113-0000 | PIVOT LINK |
| 17 | 0017-00042-0093 | NYLINER (2) |
| | A614-00042-0000 | MTG. BRKT. ASSY. (CONSISTING OF) |
| 18 | 0614-00014-0000 | MTG. BRKT. (FLIPPER) |
| 19 | 0017-00101-0754 | #8-32 x 3/8 SLOT. HEX HD. S.T.M.S. (11) |
| 20 | 0614-00039-0000 | LEVER ARM ASSY. (RIGHT) LOWER |
| 21 | 0017-00101-0520 | #5-40 x 3/8 PAN HD. MACH. SCR. (2) |
| | 0614-00040-0000 | FLIPPER ASSY. RIGHT (COMPLETE) |

Fig. 9-45. Right flipper unit assembly and parts list for Evel Knievel.

FLIPPER ASSY.



BALL TILT ASSY.

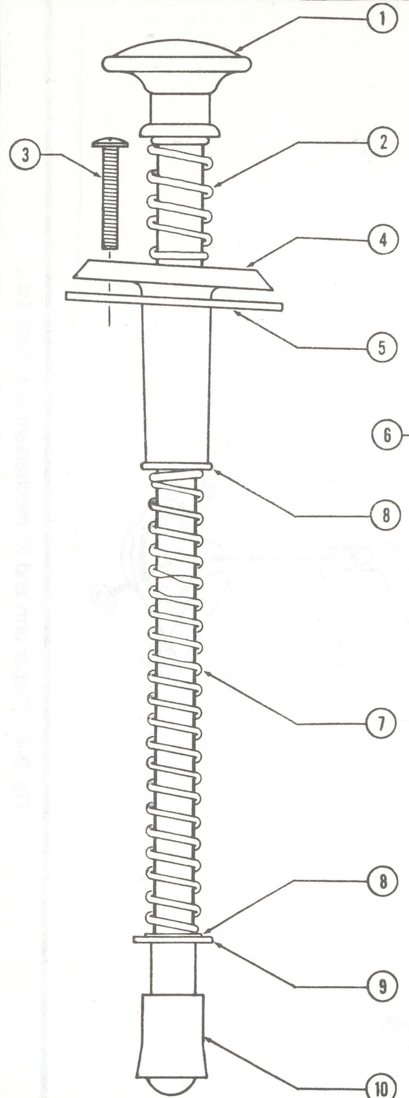


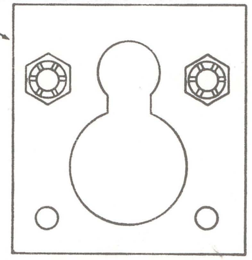
FLIPPER & BALL TILT ASS'YS

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| | | FLIPPER ASSY. |
| 1 | 0017-00042-0142 | FLIPPER HOUSING |
| 2 | 0017-00009-0357 | FLIPPER RUBBER |
| 3 | 0606-00039-0000 | SHAFT & MTG BRKT. ASSY. |
| 4 | 0017-00101-0014 | #6 x 1/2 SELF TAP SCREW |
| | A614-00032-0000 | FLIPPER ASSY. (COMPLETE) CAPT. FANTASTIC & FIREBALL II (2 REQ'D.) EVEL KNIEVEL - (3 REQ'D.) |
| | | BALL TILT ASSY. |
| 1 | 0017-00009-0371 | TILT HANGER |
| 2 | 0010-00241-0000 | PLUMB BOB WIRE |
| 3 | 0017-00009-0373 | PLUMB BOB W/THUMB SCREW |
| 4 | 0017-00009-0372 | TILT CONTACT BRACKET |

Fig. 9-46. Flipper arm and tilt mechanism with parts lists.



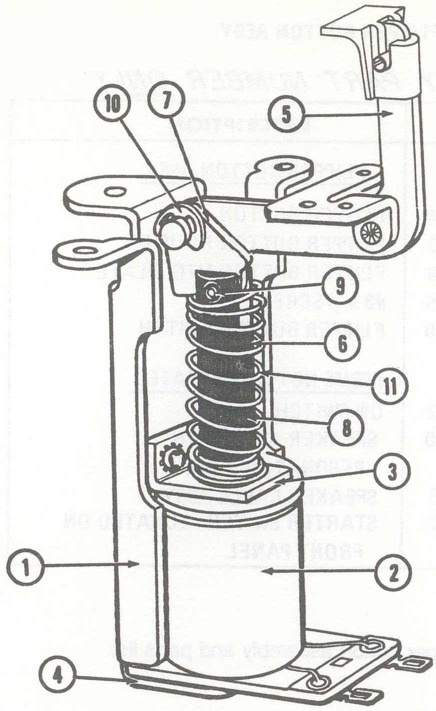



BALL SHOOTER PLATE
(INSIDE OF CABINET)

ORDER BY PART NUMBER ONLY

| ITEM | PART № | DESCRIPTION |
|---|---|---|
| 1 | 0606-00047-0000 | KNOB & SHOOTER ROD ASSEMBLY |
| 2 | 0010-00235-0000 | COMPRESSION SPRING - SHORT |
| 3 | 0017-00101-0777 | #10 - 32 X 1¼ PHIL. PAN. HD. M.S. - NICKEL PLATED (2 REQ'D.) |
| 4 | 0017-00009-0406 | SHOOTER GUIDE |
| 5 | 0614-00107-0000 | BACK UP PLATE |
| 6 | 0614-00011-0000 | PLATE & NUT ASSEMBLY |
| 7 | 0010-00234-0000 | COMPRESSION SPRING - LONG |
| 8 | 0017-00009-0369 | SPRING CUP (2 REQ'D.) |
| 9 | 0017-00007-0126 | RETAINING RING |
| 10 | 0017-00041-0049 | ROUND TIP SHOOTER |
| | 0614-00010-0000 | BALL SHOOTER ASSY. - COMPLETE |
| | | NOT SHOWN |
| | 0017-00101-0025 | #8 X ½ HEX. HD. S.M.S. (2 REQ'D.) |

Fig. 9-47. Ball shooter assembly and parts list.




*ORDER BY PART NUMBER ONLY*

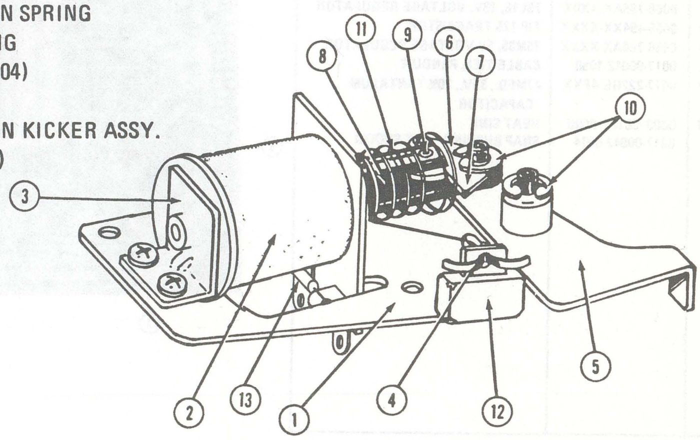
| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0606-00033-0000 | CORE PLUG ASSY. |
| 2 | A614-00017-0000 | COIL |
| 3 | 0017-00009-0341 | SOLENOID BRACKET |
| 4 | 0606-00033-0000 | CORE PLUG ASSY. |
| 5 | A614-00005-0000 | KICKER ARM ASSY. |
| 6 | 0606-00043-0000 | PLUNGER & LINK ASSY. |
| 7 | 0017-00009-0317 | KICKER LINK |
| 8 | 0606-00707-0000 | PLUNGER |
| 9 | 0017-00007-0073 | ROLL PIN 1/8 x 7/16 |
| 10 | 0017-00100-0021 | RETAINING RING |
| 11 | 0010-00239-0000 | COMPRESSION SPRING |
| | 0606-00042-0000 | CORE PLUG & COIL ASSY. |
| | A614-00006-0000 | SLINGSHOT KICKER COIL ASSY. (COMPLETE) |

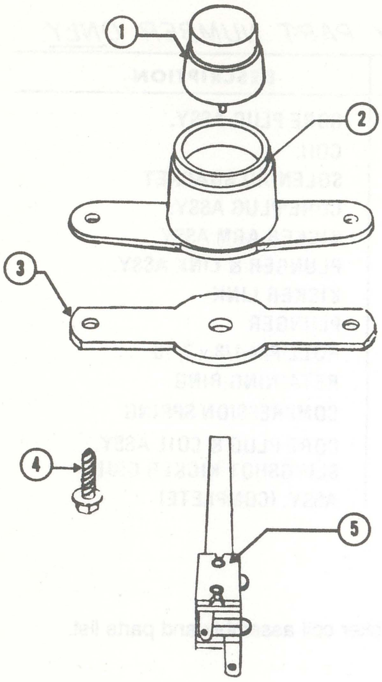
Fig. 9-48. Sling shot kicker coil assembly and parts list.

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0606-00045-0000 | BASE PLATE ASSY. |
| 2 | A614-00047-0000 | COIL ASSY. |
| 3 | 0606-00032-0000 | CORE PLUG ASSY. |
| 4 | 0017-00007-0124 | 3/32 x 3/8 COTTER PIN |
| 5 | 0606-00044-0000 | KICKER ARM ASSY. |
| 6 | 0606-00043-0000 | PLUNGER & LINK ASSY. |
| 7 | 0017-00009-0317 | KICKER LINK |
| 8 | 0606-00707-0000 | PLUNGER |
| 9 | 0017-00007-0073 | 1/8 DIA. x 7/16 ROLL PIN |
| 10 | 0017-00100-0021 | RETAINING RING (2) |
| 11 | 0010-00240-0000 | COMPRESSION SPRING |
| 12 | 0017-00042-0120 | STRIKER RING |
| 13 | 0064-030XX-XXXX | DIODE (IN 4004) |
| | 0606-00009-0000 | BALL RETURN KICKER ASSY. (COMPLETE) |

Fig. 9-49. Ball return kicker assembly and parts list.





FLIPPER BUTTON ASSY.

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| | | FLIPPER BUTTON ASSY. |
| 1 | 0017-00042-0144 | FLIPPER BUTTON |
| 2 | 0017-00042-0143 | FLIPPER BUTTON HOUSING |
| 3 | 0017-00009-0366 | FLIPPER BUTTON MTG. PLATE |
| 4 | 0017-00101-0025 | #8 x ½ SCREW (2) |
| 5 | 0606-00016-0000 | FLIPPER BUTTON SWITCH |
| | | ITEMS NOT ILLUSTRATED |
| | 0017-00005-0182 | ON SWITCH |
| | A614-00012-0000 | SPEAKER ASSY. WITH RESONATOR CONE |
| | 0614-00048-0000 | SPEAKER CABLE ASSY. |
| | 0017-00005-0182 | STARTER SWITCH - LOCATED ON FRONT PANEL |

Fig. 9-50. Flipper button assembly and parts list.

POWER SUPPLY P.C. BOARD ASSY.
CAPT. FANTASTIC ONLY

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0614-00912-0000 | P.C. BOARD |
| 2 | 0064-168FF-XXXX | RECTIFIER - A14F (4 REQ'D.) |
| 3 | 0064-169FF-XXXX | RECTIFIER - A15F (4 REQ'D.) |
| 4 | 0017-00021-0271 | WAFER, 90° POL., - 4 PIN (2 REQ'D.) |
| 5 | 0017-00021-0258 | WAFER, 90° POL., - 6 PIN |
| 6 | 0017-00021-0262 | WAFER, 90° POL., - 11 PIN |
| 7 | 0061-326DX-5EXX | 20,000 MFD., 16 V., ELECTROLYTIC AXIAL CAPACITOR |
| 8 | 0061-322CX-5EXX | 10,000 MFD., 35 V., ELECTROLYTIC AXIAL CAPACITOR |
| 9 | 0061-148G6-4FXX | .33 MFD., 35 V., 20% CAPACITOR TANTALUM CAPACITOR |
| 10 | 0062-110B3-1XXX | 1/4 W, 5% RESISTOR - 100 OHM |
| 11 | 0066-785AX-XX0X | 78L18, 18V. VOLTAGE REGULATOR |
| 12 | 0065-494XX-XXXX | TIP 125 TRANSISTOR |
| 13 | 0066-786AX-XXXX | 78M05, 5V VOLTAGE REGULATOR |
| 14 | 0017-00042-1050 | CABLE TIES, PANDUIT |
| 15 | 0017-222GG-4FXX | 47MFD., 35V., 20% TANTALUM CAPACITOR |
| 16 | 0080-00102-0000 | HEAT SINK |
| | 0017-00042-0014 | SNAP BUSHING - NOT SHOWN |

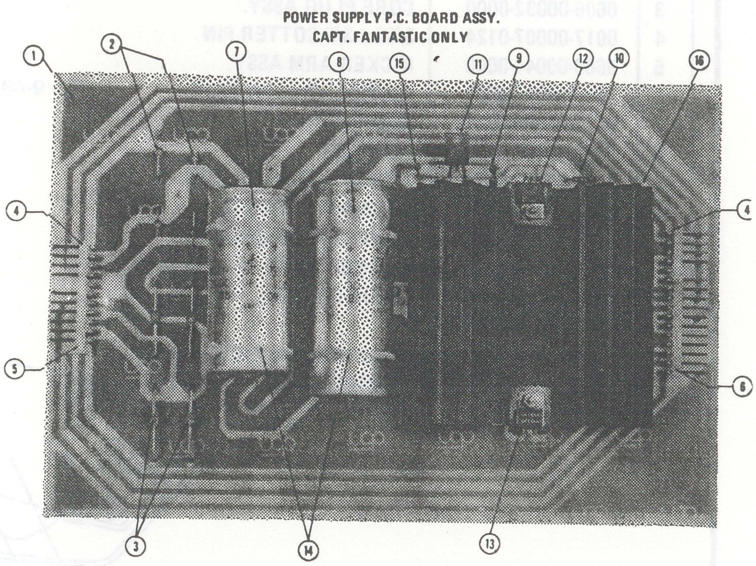



Fig. 9-51. Captain Fantastic (614-00912) power supply and parts list.

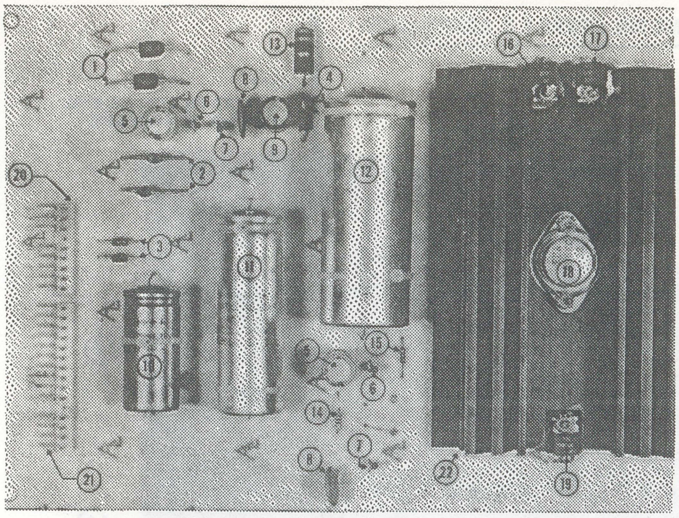


Fig. 9-52. Evel Knievel/Fireball II (606-00906) power supply and parts list.

**NO. 0606 POWER SUPPLY P.C. BOARD ASSY.**
**EVEL KNIEVEL & FIREBALL II**

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0064-166XX-XXHX | 60SI DIODE (2) |
| 2 | 0064-150XX-XXGX | IN 5624 DIODE (2) |
| 3 | 0064-025XX-XXCX | IN 4001 DIODE (2) |
| 4 | 0064-143XX-XXXX | IN 5355 B 18V ZENER DIODE 5W 5% |
| 5 | 0061-271DX-5FXX | 470 MF 16V ELECTROLYTIC RADIAL CAPACITOR |
| 6 | 0061-163EX-4FRX | 1MF 25V TANTALUM CAPACITOR (2) |
| 7 | 0061-148G6-4FXX | .33MF 35V 20% TANTALUM CAPACITOR |
| 8 | 0061-132HX-1AXXX | .1MF 50V CER. DISC. CAPACITOR (2) |
| 9 | 0061-224GX-5FBX | 50MF 35V ELECTROLYTIC RADIAL CAPACITOR |
| 10 | 0061-291GX-5EXX | 1000MF 35V ELECTROLYTIC AXIAL CAPACITOR |
| 11 | 0061-326DX-5EXX | 20,000MF 16V ELECTROLYTIC AXIAL CAPACITOR |
| 12 | 0061-322GX-5E2X | 10,000 35V ELECTROLYTIC AXIAL CAPACITOR |
| 13 | 0062-074J3-1XXX | 30 OHM 5W 5% RESISTOR |
| 14 | 0062-101B3-1XXX | 75 OHM 1/4W 5% RESISTOR |
| 15 | 0062-171B3-1XXX | 750 OHM 1/4W 5% RESISTOR |
| 16 | 0065-388XX-XXCX | FT. 3055 TRANSISTOR |
| 17 | 0066-786AX-XXBX | 78MD 5 UC VOLTAGE REGULATOR |
| 18 | 0066-783AX-XXBX | 7805 KC VOLTAGE REGULATOR |
| 19 | 0066-792AX-XXBX | 78M12 UC VOLTAGE REGULATOR |
| 20 | 0017-00021-0253 | 9 PIN JACK |
| 21 | 0017-00021-0256 | 15 PIN JACK |
| 22 | 0080-00100-0000 | HEAT SINK |
| | 0017-00042-0014 | SNAP BUSHING - NOT SHOWN |
| | 0606-00906-0000 | POWER SUPPLY (COMPLETE) |

**NO. 614 HOME PIN UPPER P.C. BOARD ASSY.**

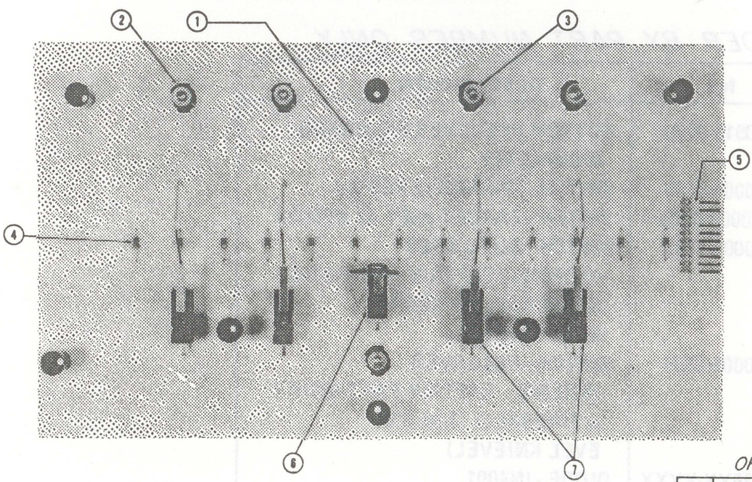
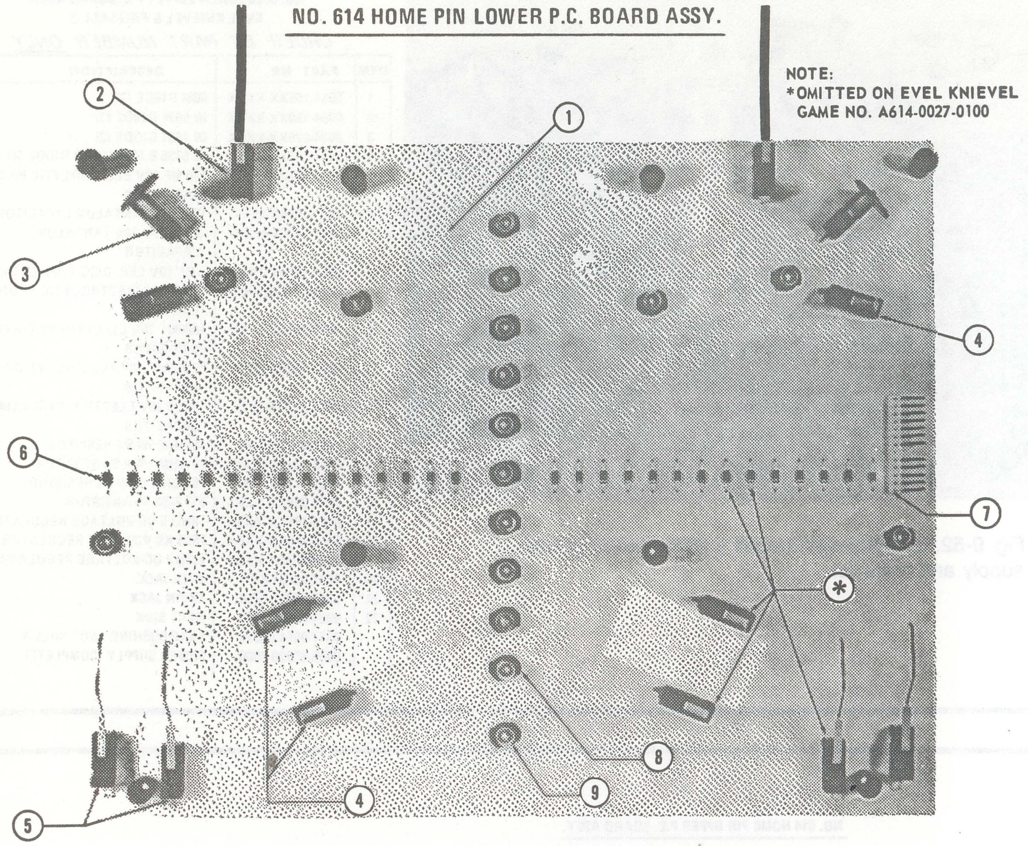


Fig. 9-53. Upper PC board assembly and parts list.

**NO. 614 HOME PIN UPPER P.C. BOARD ASSY.**

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0614-00914-0000 | TOP ROLLOVER P.C. BOARD (COMPLETE) |
| 2 | 0017-00031-0029 | LAMP SOCKET (5 REQ'D.) |
| 3 | 0017-00003-0182 | LAMP #147 (5 REQ'D.) |
| 4 | 0064-025XX-XXXX | DIODE - IN4001 (13 REQ'D.) |
| 5 | 0017-00021-0254 | CONNECTOR - 10 PIN |
| 6 | A606-00004-0000 | SWITCH - TARGET ASSY. |
| 7 | 0017-00005-0184 | SWITCH - ROLLOVER (4 REQ'D.) |
| | A614-00037-0000 | JUMPER CABLE ASSY. (4 REQ'D.) |
| | 0614-00911-0100 | SPACER WITH LOCATOR COLLAR |
| | 0614-00911-0200 | SPACER WITHOUT LOCATOR COLLAR |




*ORDER BY PART NUMBER ONLY*

| ITEM | PART № | DESCRIPTION |
|---|---|---|
| 1 | 0614-00915-0000 | BOTTOM ROLLOVER P.C. BOARD (COMPLETE) |
| 2 | 0017-00005-0186 | SWITCH - SPINNER (2 REQ'D.) |
| 3 | A606-00004-0000 | SWITCH - TARGET ASSY. (2 REQ'D.) |
| 4 | 0017-00005-0185 | SWITCH - SLING SHOT (6 REQ'D. - CAPTAIN FANTASTIC & FIREBALL) (4 REQ'D. - EVEL KNIEVEL) |
| 5 | 0017-00005-0184 | SWITCH - ROLLOVER (4 REQ'D. - CAPTAIN FANTASTIC & FIREBALL) (3 REQ'D. EVEL KNIEVEL) |
| 6 | 0064-025XX-XXXX | DIODE - IN4001 (29 REQ'D. - CAPTAIN FANTASTIC & FIREBALL) (27 REQ'D. - EVEL KNIEVEL) |
| 7 | 0017-00021-0255 | CONNECTOR - 13 PIN |
| 8 | 0017-00031-0029 | LAMPSOCKET (17 REQ'D.) |
| 9 | 0017-00003-0182 | LAMP #147 (17 REQ'D.) |
| | 0614-00911-0100 | SPACER WITH LOCATOR COLLAR |
| | 0614-00911-0200 | SPACER WITHOUT LOCATOR COLLAR |

Fig. 9-54. Lower PC board assembly and parts list.

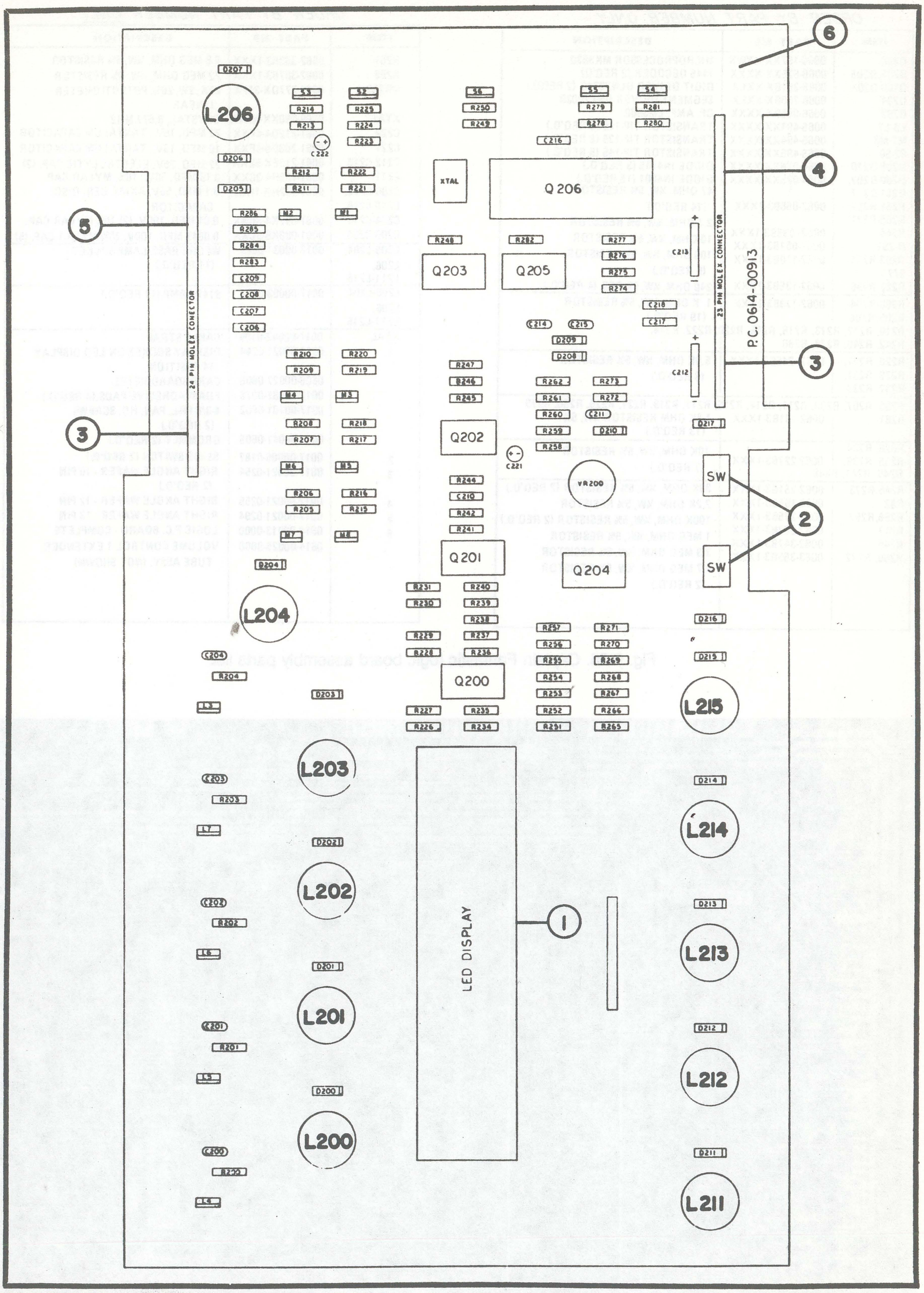



Fig. 9-55. Captain Fantastic logic board diagram.

ORDER BY PART NUMBER ONLY

| ITEM | PART № | DESCRIPTION |
|---|---|---|
| Q206 | 0066-197XX-XXWX | MICROPROCESSOR MK3870 |
| Q203, Q205 | 0066-675XX-XXXX | 7445 DECODER (2 REQ'D) |
| Q200-Q201 | 0066-261BX-XXLX | DIGIT DRIVER ULN2074B (2 REQ'D.) |
| Q204 | 0066-260BX-XXLX | SEGMENT DRIVER UNL2003B |
| Q202 | 0066-065BX-XXXX | OP. AMP. LM3900 |
| L3-L7 | 0065-491XX-XXXX | TRANSISTOR TIP-110 (5 REQ'D.) |
| M1-M8 | 0065-494XX-XXXX | TRANSISTOR TIP-125 (8 REQ'D.) |
| S2-S6 | 0065-495XX-XXXX | TRANSISTOR TIP-145 (5 REQ'D.) |
| D208-D210 | 0064-038XX-XXXX | DIODE IN4148 (3 REQ'D.) |
| D200-D207, D211-D217 | 0064-025XX-XXXX | DIODE IN4001 (15 REQ'D.) |
| R251-R257, R265-R271 | 0062-086B3-1XXX | 47 OHM, ¼W, 5% RESISTOR (14 REQ'D.) |
| R244 | 0062-036B3-1XXX | 2.7 OHM, ¼W, 5% RESISTOR |
| R-238 | 0062-051B3-1XXX | 10 OHM, ¼W, 5% RESISTOR |
| R256, R274-277 | 0062-110B3-1XXX | 100 OHM, ¼W, 5% RESISTOR (5 REQ'D.) |
| R283-R286 | 0062-135B3-1XXX | 240 OHM, ¼W, 5% RES. (4 REQ'D.) |
| R200-R204-R206, R208, R210, R212, R213, R216, R218, R220, R222, R224, R242, R249, R278, R280 | 0062-179B3-1XXX | 1 K OHM, ¼W, 5% RESISTOR (19 REQ'D.) |
| R226, R227, R229, R231, R237, R239 | 0062–215B3-1XXX | 5.6K OHM, ¼W, 5% RESISTOR (6 REQ'D.) |
| R205, R207, R209, R211, R214, R215, R217, R219, R221, R225, R250, R279, R281 | 0062-191B3-1XXX | 1.8K OHM RESISTOR ¼W, 5% (13 REQ'D.) |
| R228, R234, R235, R239, R240, R241, R248 | 0062-227B3-1XXX | 10K OHM, ¼W, 5% RESISTOR (7 REQ'D.) |
| R245, R273 | 0062-251B3-1XXX | 33K OHM, ¼W, 5% RESISTOR (2 REQ'D.) |
| R82 | 0062-195B3-1XXX | 2.2K OHM, ¼W, 5% RESISTOR |
| R258, R262 | 0062-275B3-1XXX | 100K OHM, ¼W, 5% RESISTOR (2 REQ'D.) |
| R247 | 0062-323B3-1XXX | 1 MEG OHM, ¼W, 5% RESISTOR |
| R246 | 0062-347B3-1XXX | 3.3 MEG OHM, ¼W, 5% RESISTOR |
| R260, R272 | 0063-355B3-1XXX | 4.7 MEG OHM, ¼W, 5% RESISTOR (2 REQ'D.) |

ORDER BY PART NUMBER ONLY

| ITEM | PART № | DESCRIPTION |
|---|---|---|
| R261 | 0062-363B3-1XXX | 6.8 MEG OHM, ¼W, 5% RESISTOR |
| R259 | 0062-387B3-1XXX | 22 MEG OHM, ¼W, 5% RESISTOR |
| VR200 | 0063-277DX-31FX | 25K, 2W, 20%, POTENTIOMETER LINEAR |
| XTAL | 0069-080XX-XX4X | CRYSTAL, 3.577 MHZ |
| C222 | 0061-212D4-4FXX | 22 MFD, 16V., TANTALUM CAPACITOR |
| C221 | 0061-203D6-4FXX | 10 MFD, 16V., TANTALUM CAPACITOR |
| C212-C213 | 0061-212EX-5EXX | 22 MFD, 25V. ELECTROLYTIC CAP. (2) |
| C211 | 0061-136H4-3CXX | 0.15 MFD, 50V., 10%, MYLAR CAP. |
| C206-C210, C216-C218 | 0061-132HX-1IXX | 0.1 MFD, 50V. AXIAL CER. DISC. CAPACITOR |
| C214-C215 | 0061-097K4-3CXX | 0.01 MFD, 100V, (2) 10% MYLAR CAP. |
| C200-C204 | 0061-088K6-3CXX | 0.0047 MFD, 100V. 20% MYLAR CAP. (5) |
| L200-L204, L206, L211-L215 | 0017-00031-0029 | WEDGE BASE LAMP SOCKET (11 REQ'D.) |
| L200-L204, L206, L211-L215 | 0017-00003-0182 | #147 LAMP (11 REQ'D.) |
| XTAL | 0017-00042-0105 | CABLE STRAP |
| 1 | 0017-00021-0244 | DISPLAY SOCKET ON LED DISPLAY 14 POSITION |
| | 0606-00927-0000 | CARDBOARD BEZEL |
| | 0017-00081-0078 | FOAM ADHESIVE PADS (4 REQ'D.) |
| | 0017-00101-0002 | 4-3/8 PHL. PAN. HD. SCREWS (2 REQ'D.) |
| | 0017-00041-0606 | GROMMET (2 REQ'D.) |
| 2 | 0017-00005-0187 | SLIDE SWITCH (2 REQ'D.) |
| 3 | 0017-00021-0254 | RIGHT ANGLE WAFER - 10 PIN (2 REQ'D.) |
| 4 | 0017-00021-0255 | RIGHT ANGLE WAFER - 12 PIN |
| 5 | 0017-00021-0294 | RIGHT ANGLE WAFER - 13 PIN |
| 6 | 0614-00913-0000 | LOGIC P.C. BOARD - COMPLETE |
| | 0614-00025-0000 | VOLUME CONTROL 1 EXTENDER TUBE ASSY. (NOT SHOWN) |

Fig. 9-56. Captain Fantastic logic board assembly parts list.

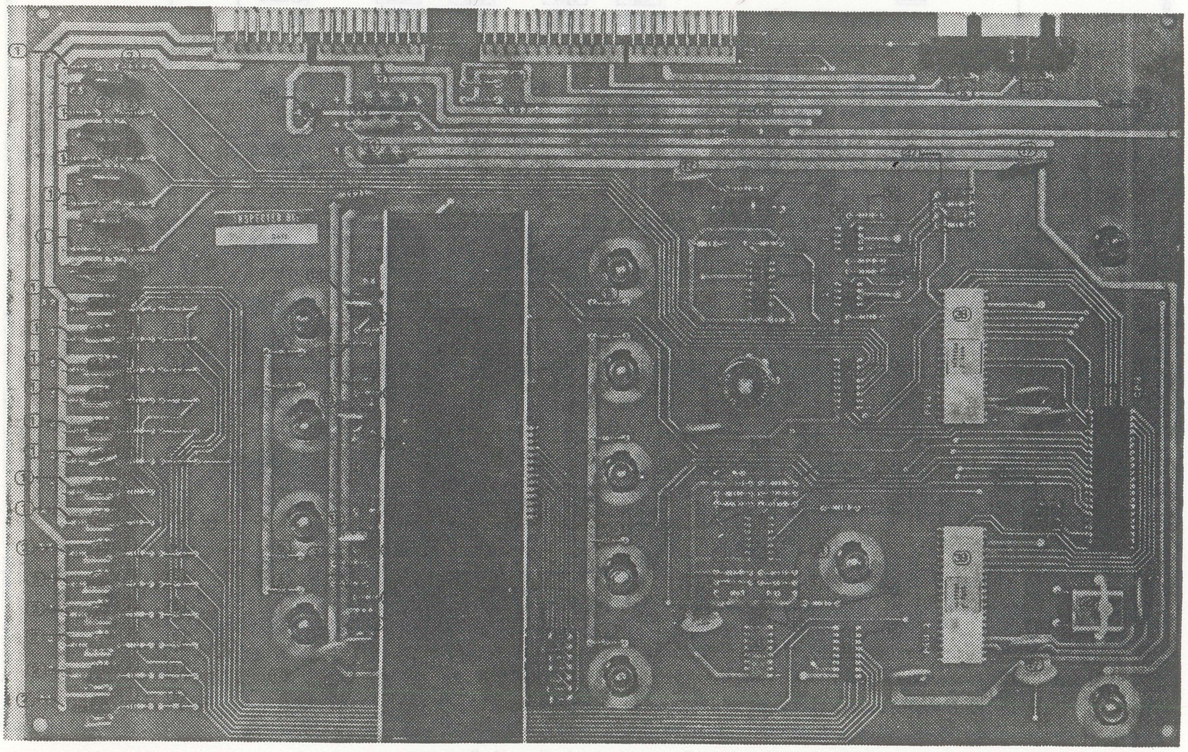


Fig. 9-57. Evel Knievel/Fireball II logic board diagram.

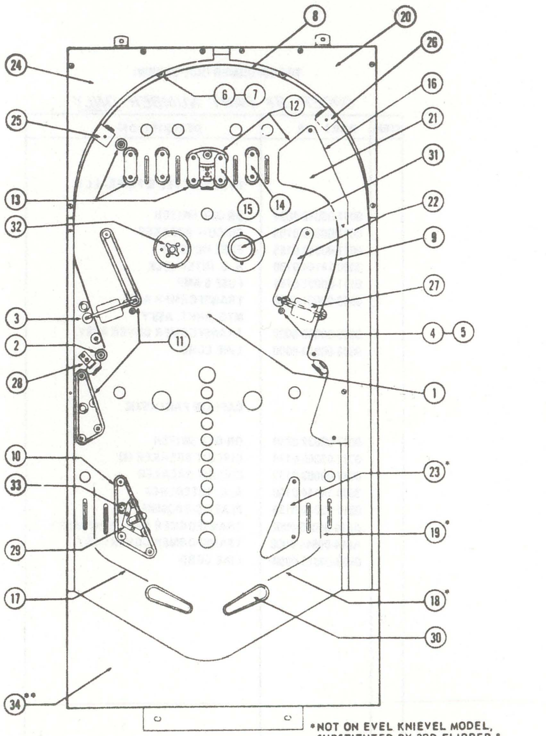
*ORDER BY PART NUMBER ONLY*

| ITEM | PART № | DESCRIPTION |
|---|---|---|
| 1 | 0062-195B3-1XXX | 2.2 K, ¼W, 5% RESISTOR (18) |
| 2 | 0062-179B3-1XXX | 1K, ¼W, 5% RESISTOR (26) |
| 3 | 0065-495XX-XXMX | T.I.P. 145 TRANS. (5) |
| 4 | 0065-493XX-XXMX | T.I.P. 115 TRANS. (14) |
| 5 | 0064-025XX-XXXX | DIODE 1N4001 (28) |
| 6 | 0017-00021-0253 | RIGHT ANGLE WAFER (9 PIN) (1) |
| 7 | 0017-00021-0254 | RIGHT ANGLE WAFER (10 PIN) (2) |
| 8 | 0017-00021-0255 | RIGHT ANGLE WAFER (13 PIN) (1) |
| 9 | 0017-00005-0187 | SLIDE SWITCH SPOT - (2) |
| 10 | 0065-452XX-XXCX | MPS 6531 (TRANSISTOR) (1) |
| 11 | 0061-212EX-5EXX | 22 MF 25V ELECTROLYTIC CAP. (S) |
| 12 | 0061-089K6-1A6X | .005 MF 100V., 20%, CER. DISC. CAP.(4) |
| 13 | 0065-491XX-XXMX | TIP 100 TRANSISTOR (4) |
| 14 | 0062-199B3-1XXX | 2.7 K, ¼W, 5% RESISTOR (5) |
| 15 | 0062-053D3-1XXX | 12 OHM ½ WATT, RESISTOR (5) |
| 16 | 0062-133B3-1XXX | 220 OHM, ¼W, 5% RESISTOR (1) |
| 17 | 0061-132H8-1AMX | .1 MF, 50V., CER. DISC. CAP. (13) |
| 18 | 0061-132HX-1AXC | .1 MF , 50V., CER DISC. Z5U CAP. (1) |
| 19 | 0062-122B3-1XXX | 150 OHM, ¼W, 5% RESISTOR (1) |
| 20 | 0062-063H3-1XXX | 22 OHM 2 WATT RESISTOR (1) |
| 21 | 0062-110B3-1XXX | 100 OHM,¼W, 5% RESISTOR (1) |
| 22 | 0066-970AX-XXBX | FPQ 3724 TRANSISTOR ARRAY (1) |
| 23 | 0063-260DX-31FX | 5K 2W POT (1) |
| 24 | 0062-287B3-1XXX | 22 MEG OHM, ¼W, 5% RES. (1) |
| 25 | 0062-355B3-1XXX | 4.7 MEG, ¼W, 5% RESISTOR (2) |
| 26 | 0062-363B3-1XXX | 6.8 MEG OHM, ¼W, 5% RES. (1) |
| 27 | 0062-275B3-1XXX | 100K, ¼W, 5% RESISTOR (2) |
| 28 | 0066-230BX-XXBX | VA 3401 I.C. (1) |
| 29 | 0062-347B3-1XXX | 3.3 MEG, ¼W, 25V., 5% RES. (1) |
| 30 | 0061-097EX-1ALC | .01 MF 25V. CER. DISC., Z5U CAP (2) |
| 31 | 0062-323B3-1XXX | 1 MEG OHM, ¼W, 5%, RES. (1) |
| 32 | 0062-227B3-1XXX | 10K, ¼W, 5%, RESISTOR (1) |
| 33 | 0066-690XX-XXXX | 7448 I.C. (1) |
| 34 | 0066-675XX-XXBX | 7445 I.C. (2) |
| 35 | 0062-144B3-1XXX | 330 OHM, ¼W, 5%, RESISTOR (4) |

*ORDER BY PART NUMBER ONLY*

| ITEM | PART № | DESCRIPTION |
|---|---|---|
| 36 | 0069-005XX-XXHX | ILD 74 I.C. (2) |
| 37 | 0062-211B3-1XXX | 4.7 K, OHM, ¼W, 5% RESISTOR (1) |
| 38 | 0066-193XX-XXB1 | SL 31 281 PSU #1 (SL 31280) (1) |
| 39 | 0066-193XX-XXB2 | SL 31 281 PSU 2 (1) |
| 40 | 0061-022P4-2BKX | 15 PF, 500V, 10%, MICA CAP. (2) |
| 41 | 0066-191XX-XXBX | C.P.U. 3850 (1) |
| 42 | 0069-068XX-XXJX | 2 MHZ CRYSTAL (1) |
| 43 | 0066-870AX-XXBX | FSC 9667 I.C. (1) |
| 44 | 0069-058XX-XXHX | SCORE DISPLAY DL-6830 |
| | | NOT SHOWN |
| | 0062-227B3-1XXX | 10K OHM, ¼W, 5% RESISTOR (1) |
| | 0062-235B3-1XXX | 15K OHM, ¼W, 5% RESISTOR (1) |
| | 0061-212D4-4FPX | 22 MF, 16V, 10% TANTALUM CAP. (1) |
| | 0614-00025-0000 | VOLUME CONTROL EXTENDER TUBE ASSY. |

Fig. 9-58. Evel Knievel/Fireball II logic assembly parts list.



*NOT ON EVEL KNIEVEL MODEL, SUBSTITUTED BY 3RD FLIPPER & SHAFT ASSEMBLY NO. 0606-00014 & LIGHT SHIELD SLINGSHOT (RIGHT) NO. 0614-00910-0700.

*ORDER BY PART NUMBER ONLY*

| ITEM | PART № | DESCRIPTION |
|---|---|---|
| 1 | 0614-00502-0100 | PLAYFIELD (SCREENED) - EVEL KNIEVEL |
| | 0614-00504-0100 | PLAYFIELD (SCREENED) - CAPT. FANTASTIC |
| | 0614-00504-0200 | PLAYFIELD (SCREENED) - FIREBALL II |
| 2 | 0614-00908-0000 | PUSH IN POST (31 REQ'D.) |
| 3 | 0017-00009-0362 | SHORT POST (4 REQ'D.) |
| 4 | 0017-00009-0408 | MINI POST (2 REQ'D.) |
| 5 | 0017-00041-0604 | RUBBER BUMPER (2 REQ'D.) |
| 6 | 0017-00042-0125 | RAIL POSTS (5 REQ'D.) |
| 7 | 0017-00042-0126 | RAIL POST CAP (5 REQ'D.) |
| 8 | 0606-00103-0000 | RAIL |
| 9 | 0606-00104-0000 | RAIL (SHORT) |
| 10 | 0017-00009-0309 | RUBBER 3" INSIDE DIAMETER EVEL KNIEVEL (1 REQ'D.) CAPT. FANTASTIC & FIREBALL II (2 REQ'D.) |
| 11 | 0017-00009-0306 | RUBBER 2½" INSIDE DIAMETER EVEL KNIEVEL (5 REQ'D.) CAPT. FANTASTIC & FIREBALL II(4 REQ'D.) |
| 12 | 0017-00009-0310 | RUBBER 1½" I.D. (2 REQ'D.) |
| 13 | 0017-00009-0365 | RUBBER ¼" I.D. (12 REQ'D.) |
| 14 | 0017-00042-0128 | PLASTIC GUIDE (3 REQ'D.) |
| 15 | 0017-00042-0129 | PLASTIC GUIDE (3 REQ'D.) |
| 16 | 0017-00009-0326 | BALL GUIDE (WIRE FORM) |
| 17 | 0017-00009-0299 | BALL GUIDE (WIRE FORM) |
| 18 | 0017-00009-0300 | BALL GUIDE - FIREBALL II & CAPT. FANTASTIC ONLY |
| 19 | 0017-00009-0293 | BALL GUIDE - FIREBALL II & CAPT. FANTASTIC (2) - EVEL KNIEVEL (1 REQ'D.) |
| 20 | 0614-00909-0100 | LIGHT SHIELD (RIGHT) - FIREBALL II |
| | 0614-00909-1100 | LIGHT SHIELD (RIGHT) - CAPT. FANTASTIC |
| | 0614-00910-0100 | LIGHT SHIELD (RIGHT) - EVEL KNIEVEL |

Fig. 9-59. Playfield assembly and parts list (part 1 of 2).

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| | 0614-00909-0200 | SPINNER GATE LIGHT SHIELD (LEFT) NOT SHOWN - FIREBALL II |
| | 0614-00909-1200 | SPINNER GATE LIGHT SHIELD (LEFT) NOT SHOWN - CAPTAIN FANTASTIC |
| | 0614-00910-0200 | SPINNER GATE LIGHT SHIELD (LEFT) NOT SHOWN - EVEL KNIEVEL |
| | 0614-00909-0300 | SIDE LIGHT SHIELD (LEFT) NOT SHOWN - FIREBALL II |
| | 0614-00909-1300 | SIDE LIGHT SHIELD (LEFT) NOT SHOWN - CAPT. FANTASTIC |
| | 0614-00910-0300 | SIDE LIGHT SHIELD (LEFT) NOT SHOWN - EVEL KNIEVEL |
| 21 | 0614-00909-0400 | SIDE LIGHT SHIELD (RIGHT) FIREBALL II |
| | 0614-00909-1400 | SIDE LIGHT SHIELD (RIGHT) CAPT. FANTASTIC |
| | 0614-00910-0400 | SIDE LIGHT SHIELD (RIGHT) EVEL KNIEVEL |
| | 0614-00909-0500 | LIGHT SHIELD SLING SHOT (LEFT) NOT SHOWN - FIREBALL II |
| | 0614-00909-1500 | LIGHT SHIELD SLING SHOT (LEFT) NOT SHOWN - CAPT. FANTASTIC |
| | 0614-00910-0500 | LIGHT SHIELD SLING SHOT (LEFT) NOT SHOWN - EVEL KNIEVEL |
| 22 | 0614-00909-0600 | SPINNER GATE LIGHT SHIELD (RIGHT) - FIREBALL II |
| | 0614-00909-1600 | SPINNER GATE LIGHT SHIELD (RIGHT) - CAPT. FANTASTIC |
| | 0614-00910-0600 | SPINNER GATE LIGHT SHIELD (RIGHT) - EVEL KNIEVEL |
| 23 | 0614-00909-0700 | LIGHT SHIELD SLING SHOT (RIGHT) - FIREBALL II |
| | 0614-00909-1700 | LIGHT SHIELD SLING SHOT (RIGHT) - CAPT. FANTASTIC |

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| | 0614-00910-0700 | LIGHT SHIELD SLING SHOT (RIGHT) - EVEL KNIEVEL |
| | 0614-00909-0800 | TOP CENTER LIGHT SHIELD - NOT SHOWN - FIREBALL II |
| | 0614-00909-1800 | TOP CENTER LIGHT SHIELD - NOT SHOWN - CAPT. FANTASTIC |
| | 0614-00910-0800 | TOP CENTER LIGHT SHIELD - NOT SHOWN - EVEL KNIEVEL |
| 24 | 0614-00909-0900 | LIGHT SHIELD (LEFT) - FIREBALL II |
| | 0614-00909-1900 | LIGHT SHIELD (LEFT) - CAPT. FANTASTIC |
| | 0614-00910-0900 | LIGHT SHIELD (LEFT) - EVEL KNIEVEL |
| 25 | 0606-00013-0000 | BALL GATE (LEFT) |
| 26 | 0606-00012-0000 | BALL GATE (RIGHT) |
| 27 | A606-00005-0100 | SPINNER GATE ASSY. (2 REQ'D.) FIREBALL II & EVEL KNIEVEL |
| | A614-00023-0000 | SPINNER GATE ASSY. CAPT. FANTASTIC |
| | A614-00024-0000 | SPINNER GATE ASSY. W/GOGGLES CAPT. FANTASTIC |
| 28 | 0606-00118-0000 | BACK UP BRKT. TARGET (3 REQ'D.) |
| 29 | 0606-00126-0000 | BACK UP BRKT. SLING SHOT (2 REQ'D.) EVEL KNIEVEL (1 REQ'D.) |
| 30 | 0606-00014-0000 | FLIPPER & SHAFT ASSY. (2 REQ'D.) EVEL KNIEVEL (3 REQ'D.) |
| 31 | 0606-00011-0000 | THUMPER BUMPER ASSY. - MINUS CAP & SCREWS (2 REQ'D.) |
| 32 | 0017-00003-0061 | THUMPER BUMPER LAMP (2 REQ'D.) |
| 33 | 0017-00003-0182 | LAMP (NOTE: ALL LAMPS ARE THE SAME ON PLAYFIELD EXCEPT THE 2 THUMPER BUMPER LAMPS) |
| 34 | A614-00028-0000 | BOTTOM ARCH ASSY. - FIREBALL II |
| | A614-00018-0000 | BOTTOM ARCH ASSY. - CAPT. FANTASTIC |
| | A614-00035-0000 | BOTTOM ARCH ASSY. - EVEL KNIEVEL (NOTE: SEE SEPARATE ILLUSTRATION PAGE 38 FOR BOTTOM ARCH ASSY.) |

Fig. 9-60. Playfield assembly parts list (part 2 of 2).

**NO. 614 BOTTOM ARCH ASSY.**

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| 1 | 0614-00906-0100 | BOTTOM ARCH - EVEL KNIEVEL |
| | 0614-00906-0200 | BOTTOM ARCH - CAPT. FANTASTIC |
| | 0614-00906-0300 | BOTTOM ARCH - FIREBALL II |
| 2 | 0614-00905-0100 | BALL RUNWAY - EVEL KNIEVEL |
| | 0614-00905-0200 | BALL RUNWAY - CAPT. FANTASTIC & FIREBALL II |
| 3 | 0606-00009-0000 | KICKER ASSY. - BALL RETURN |
| 4 | 0614-00924-0000 | INSTRUCTION CARD - CAPTAIN FANTASTIC & FIREBALL II |
| | 0614-00925-0000 | INSTRUCTION CARD - EVEL KNIEVEL |
| 5 | 0614-00926-0000 | RATING CARD |
| 6 | 0017-00009-0407 | SWITCH - BALL RETURN |

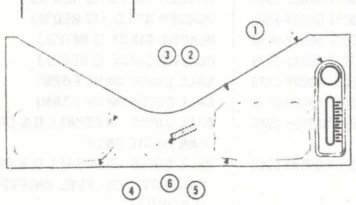



Fig. 9-61. Bottom arch assembly and parts list.

**TRANSFORMER (NOT SHOWN)**

*ORDER BY PART NUMBER ONLY*

| ITEM | PART Nº | DESCRIPTION |
|---|---|---|
| | | **EVEL KNIEVEL & FIREBALL II** |
| | 0017-00032-0039 | ON-OFF SWITCH |
| | 0017-00003-0185 | CIRCUIT BREAKER |
| | 0017-00003-0155 | FUSE HOLDER |
| | 3000-14144-0100 | A. C. INTERLOCK |
| | 0017-00003-0184 | FUSE 8 AMP |
| | 0606-00021-0000 | TRANSFORMER AND MTG. BRKT. ASS'Y. |
| | 0606-00058-0000 | TRANSFORMER COVER ASSY. |
| | 0606-00913-0000 | LINE CORD |
| | | **CAPTAIN FANTASTIC** |
| | 0017-00032-0039 | ON-OFF SWITCH |
| | 0017-00003-0179 | CIRCUIT BREAKER (4) |
| | 0017-00003-0193 | CIRCUIT BREAKER |
| | 3000-14144-0100 | A. C. INTERLOCK |
| | 0017-00042-0139 | PLASTIC-GROMMET (7) |
| | A614-00043-0000 | TRANSFORMER MTG. BRKT. ASS'Y. |
| | A614-00044-0000 | TRANSFORMER COVER ASSY. |
| | 0606-00913-0000 | LINE CORD |

Fig. 9-62. Transformer parts list.